AUG 5 1935

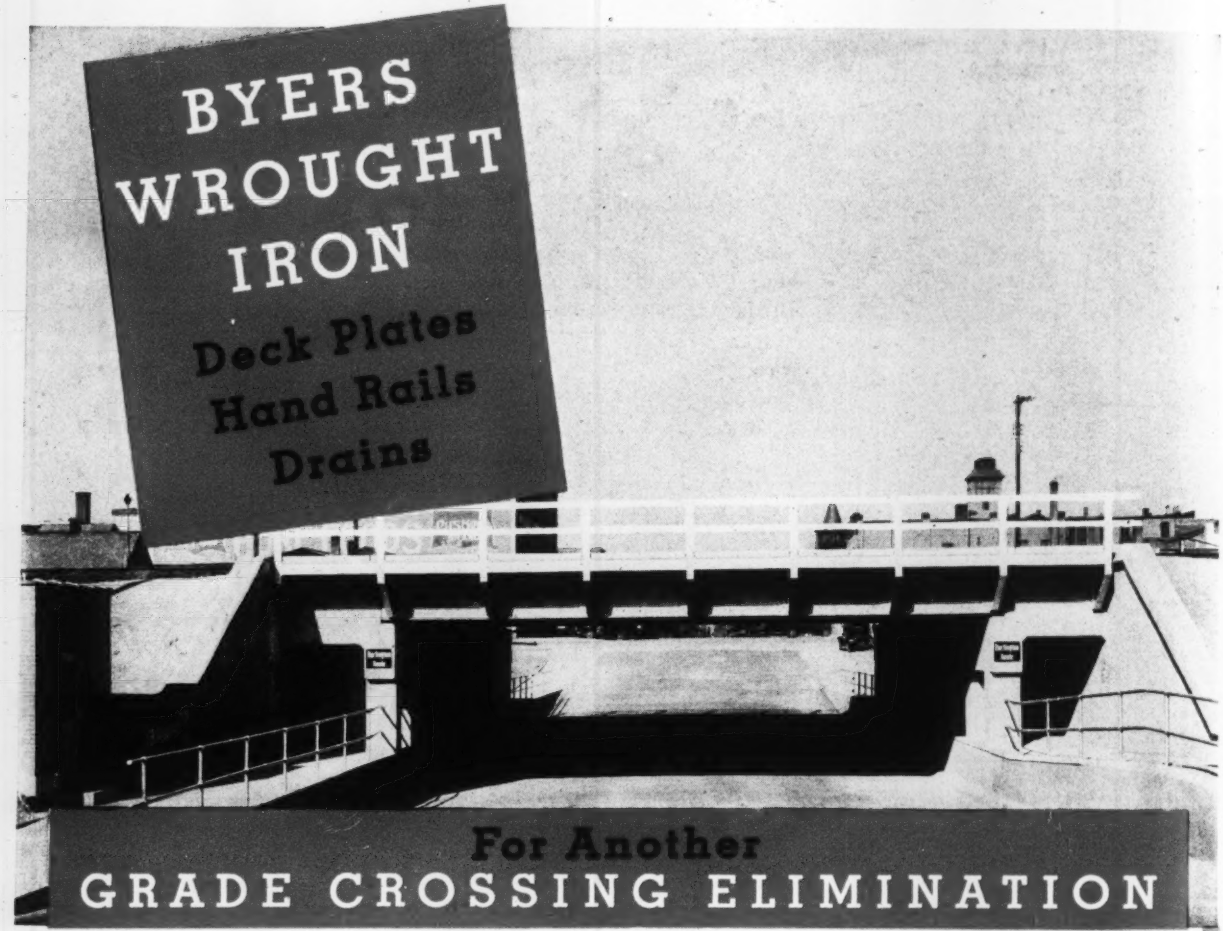
Engineering News-Record

McGraw-Hill Publishing Company, Inc. August 1, 1935 Twenty-five Cents, Five Dollars per Year

At the west abutment; the famous Grand Coulee heading southwestward at the upper right

GRAND COULEE DAM

• EIGHT AUTHORITATIVE AND UP-TO-DATE ARTICLES FROM THE FIELD outlining the huge project, the change of construction plan and the contractor's procedure in cofferdamming the site and in handling millions of yards of excavation by belt conveyors



MANY leading railroad and highway engineers are using wrought iron in grade crossing elimination work because of its ability to resist corrosion and cut maintenance costs. Furthermore, ballast decks save valuable space in clearance and floor depths.

Illustrated is another grade separation, recently completed at Hastings, Nebraska, on the C. B. & Q., where Byers Wrought Iron was used for deck plates, hand-railings and drains.

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A MOMENT WITH THE PUBLISHERS

What About TAXES?—I

RECENTLY we have had much talk about taxes. Argument, pro and con, about income taxes, inheritance taxes, corporation taxes, gasoline taxes and a raft of others have added bulk and, at times, roughage to our everyday reading diet. All this argument has spawned, in turn, a new quota of slogans. We have been so forcefully urged to "soak the rich," "share the wealth" and what-not, as the remedy for our economic ills, that many have been prone to mistake slogans for ideas and exhortation for reasoning.

The fact is, of course, that the tax structure does need a lot of revision, not merely to finance the relief and reform activities of the federal government, but even more fundamentally, to put the whole business of paying community bills on a more rational basis. But that job cannot be done by any of the short-cut panaceas that now are being hawked through the land.

THE whole structure of taxation—federal, state and local—is an amazing hodge-podge. It has grown by an incessant process of revamping to suit the passing needs of a moment, the political pressure of special-interest groups or the vague aspirations of a reform movement. Rarely has any tax measure been wisely related to what already existed. With so irresponsible a proceeding, tolerable hitherto only because the natural wealth of a new continent has been adequate to compensate for its wastes, we now are coming to face a demonstration of the truism that "the power to tax is the power to destroy."

To curb this dangerous drift we shall need better-reasoned answers to the questions that underlie the matter of payment for community services. These questions will include among others: what services should the community render to its citizens? Who benefits by each of them? What do they cost? What is the most practicable and equitable basis on which to distribute that cost and keep it at a minimum?

To be sure, some taxes are designed primarily to guide the operation of social and economic forces. A protective tariff is one of these; a graduated income tax or excess profits tax is another; inheritance taxes are a third. Without passing judgment on the merit of such measures, this comment simply recognizes their special function.

But the great bulk of the taxes are in fact a charge for some service rendered by government; and when we consider the cost of government we must remember that we have come a long way from the conception of government that prevailed when the foundations of our tax structures were laid. Then government meant little more than the administration of the civil and criminal codes and of the national defense. The cost of such services should require but a thin slice of the national income.

But when the modern community, be it federal, state or local, provides a highway or a street, a water supply or a sewage disposal plant, an education or a hospital, it no longer is performing an act of government in the original sense: it is rendering an economic or a social service and as these services increase in number or quality, the greater will be their cost.

THE more urgent, moreover, becomes the need that this cost be equitably distributed. Burdens must be balanced against benefits. Are the social values of a school system sufficiently basic to justify a general distribution of the cost over all, regardless of use? Or are the benefits of a water supply so individual and measurable that charges can be assessed directly in proportion to them? Or does some service rest on a more complicated base? Should, for example, the original cost of a highway or a water works not call for some division of cost between direct-users, land-owners and the general community?

What, moreover, may be the secondary effects of any particular tax on the economic structure? Will it tend to stimulate business enterprise or to penalize it? Will it foster employment or retard it? Will it obstruct progress in order to conserve established interests or will it give the new a free field in which to prove its merit? Will a tax policy of "all that the traffic will bear," however productive for a time, eventually dry up the sources of revenue?

(To be concluded in an early issue)

Willard Chevalier

ENGINEERING NEWS-RECORD

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Table of Contents—See Page 33

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prevented Shutdown...

and Saved Two Large 42-Inch Valves

● Two 42-in. diameter balance needle valves were seriously worn in a hydroelectric plant. They were restored to perfect condition by building-up the worn surfaces with bronze. This was done without dismantling, thus avoiding a week's shutdown.

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CONTENTS FOR AUGUST 1, 1935

VOLUME 115 NUMBER 5 COPYRIGHT 1935

Editorial Introduction 139

Grand Coulee Dam and Project 141
BY KENNETH B. KEENER

Ten Months' Progress at Grand Coulee 144

Building the First Cofferdam 148

Belt Conveyors for a Large Volume of Spoil ... 152
BY FRANCIS DONALDSON

The Belt Conveyors in Operation 153

Designing the Belt System 156
BY STANLEY M. MERCIER

Aggregate-Plant Operation at Grand Coulee ... 158

Rainfall and Floodflows in New York Area 161

Letters to the Editor 162

Editorials 164

Current News 166

The Business Side of Construction 172

Prices of Construction Materials 174

In the News:

ANOTHER EARTH DAM for the Army Engineers to build received a $4,500,000 allotment last week. Located near the confluence of the Conchas and Canadian Rivers in northeastern New Mexico, the project will serve flood-control and irrigation purposes and supply water to Tucumcari, N. M. The Conchas Dam will contain 6,500,000 cu.yd. of earth fill.

FOREIGN STEEL AND FOREIGN CEMENT are bidding for some of the U. S. relief-works money in certain seaboard states.

INSIGHT into the tremendous cost to the public of unemployment relief is furnished by a report of the Welfare Council of New York City; in 1929, $10,093,293 was spent, of which $2,599,881 was by private agencies and $7,493,412 by public agencies. In 1934, the $163,177,332 spent was divided $6,016,099 by private and $157,161,233 by public agencies. The total cost this year will be about $200,000,000, with private agencies accounting for only about $4,000,000.

WORK on the Fraser River collection works of Denver's Moffat Tunnel water supply will begin in the near future, bids having been asked for Aug. 8. The city council approved bond issues totaling about $5,500,000, to cover this and other water-supply work. A special election will be held Sept. 10.

COLORADO LOST 452 BRIDGES in its recent flood. They will cost $1,477,201 to replace, according to the official FERA report.

SKYSCRAPER FIRES are both rare and spectacular, which makes them news whenever they occur. Thanks to the use of non-combustible materials and efficient fire-reserve water supply, they are not very perilous nor very destructive. New York experienced its second and highest skyscraper fire last week, started by a short circuit in an elevator under repair at the 48th floor of the 50-story General Electric Building. Two floors were ruined, and the top 30 floors filled with smoke. A fire in the 44-story Equitable Building in 1926 damaged a number of the high floors. Other skyscraper fires—the Riverside Church and the Sherry Netherlands Hotel—involved the burning of scaffolding while the buildings were under construction.

In This Issue:
Grand Coulee Dam

- Grand Coulee Dam, under construction on the Columbia River in northern Washington, will be three times as big as Boulder Dam, now the largest concrete dam in the world by many thousands of cubic yards. . . . It is not another "power-yardstick" dam, power being merely accessory to its main function of providing irrigation water. . . . The part being built now, the base of the ultimate dam, is useful only for river regulation.
- These fundamental facts are developed further in the first article, as background for six articles that portray the up-to-the-minute picture of one of the greatest construction operations of all time. It is told how city services were provided for 3,000 people, how cofferdamming of a great "spring flood" river was planned, how 13,000 tons of 80-ft. sheetpiles were driven in making the first 60-acre enclosure, how aggregate for millions of yards of concrete will be made and handled, and finally how belt conveyors for spoil disposal have been extended to greater lengths and larger capacities than ever before.
- This issue introduces the reader to a construction classic that will command as much of his attention in the next few years as Boulder Dam has since 1931.

THE WILLAMETTE RIVER VALLEY in Oregon will be the scene of a flood-control and power-site survey as a result of a $200,000 relief-works allotment approved this week by the President.

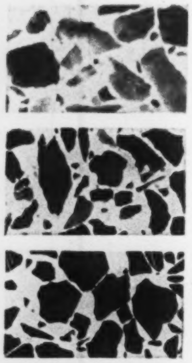
A SEWERAGE DISTRICT embracing sixteen cities in Massachusetts, including Lowell, Lawrence and Newburyport, was established last week by a state bill signed by the governor. To be known as the Merrimack Valley Sewerage District, it is the outcome of an unsuccessful attempt to create an authority that would control floods and power production as well as sanitation.

Coming Articles

THE TRIBOROUGH BRIDGE IN NEW YORK is a project involving 3½ miles of bridge structure and 14 miles of connecting boulevards. A part of the bridge is a 1,380-ft. suspension span whose two cables are spread 98 ft. apart, a new record. Largest PWA project in the East, its general layout and design are of wide interest and will be covered in a comprehensive article to be published next week.

THE FOLLOWING WEEK, erection of the towers of the Triborough suspension bridge by means of guy derricks on a falsework staging set between the tower columns will be described. The method marks a new departure in suspension-bridge tower erection.

Fine Atlas White terrazzo floor, photographed in full natural color, in U. S. Customs House and Appraisers' Store, Philadelphia. United Marble Company, terrazzo contractor. Ritter and Shay, architects. Both of Philadelphia. In panels below, at left and right, are actual-size, true-color terrazzo samples which illustrate marble and pigment combinations similar to those used for this floor.



Pink Tennessee marble, Cardiff Green marble, Belgian Black marble, white cement, yellow pigment.

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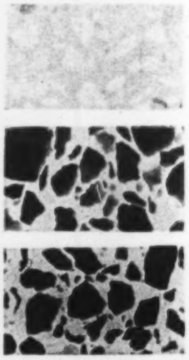
plain and waterproofed

UNIVERSAL PORTLAND CEMENT ATLAS PORTLAND CEMENT



Travertine marble, Pink Tennessee marble, Cardiff Green marble, white cement, and yellow pigment.

ENGINEERING NEWS-RECORD

Aug. 1, 1935

LOOKING ACROSS THE COLUMBIA RIVER toward the 60-acre cofferdam now being excavated for the west foundations of Grand Coulee Dam.

PROGRESS AT GRAND COULEE

In the Northwest on the Columbia River the world's largest concrete dam is going up . . . Construction methods and mechanism are being extended to new horizons . . . The present issue records what they are accomplishing

Editorial Introduction

GRAND COULEE occupies a sensational place in the public-works-for-employment program. It has been the object of political seeking, impulsive action and violent controversy over economic value, ultimate function and engineering design. Withal it is one of the greatest construction operations of all time, and this operation is being carried on with a speed and vigor and an ingenuity of attack that make it extraordinary. These construction features are discussed in the present issue. The account is up-to-the-minute; it carries the story to the stage where general planning is completed and a decisive attack has been made on the actual construction.

The Grand Coulee dam, as now planned, is the essential element of a project to equalize the flow of the Columbia River, to develop its power and to reclaim by irrigation 1,200,000 acres of land in eastern central Washington. This is the Columbia Basin reclamation project—talked of and variously planned for decades past. Definite planning of the dam as an irrigation dam, with power development for irrigation pumping and for supply to the reclaimed territory, is the decision of the last half year since construction has been in progress.

In the hectic days of the middle of 1933 the project started as a $63,000,000 improvised power development, a fragment of the fully planned development that, including the land-irrigation structures, had been estimated to cost some $375,000,000. The initial power scheme and the "low dam" that was hastily designed to make it possible have been dropped, and at present only the base section of the ultimate high dam is being built, without power installation. The expenditure involved in the current work remains at $63,000,000.

THE PRESENT SITUATION came about because the work was begun without studied design or purposeful conception of ultimate service value. With the first billions of federal money available for the public works campaign initiated in 1933, Grand Coulee Dam in

Washington, along with Bonneville Dam in Oregon and the Fort Peck Dam in Montana, was selected as a promising project, and at the same time as satisfying the political claims of the far northwest states for consideration in unemployment-relief-works allotments. Grand Coulee was the first to receive allotment, but not as part of the long-considered Columbia Basin irrigation development. Instead, it was projected primarily as a power development—one of the federal regulatory power systems that were receiving administration approval and promotion. Grand Coulee was to be the federal power yardstick for the Northwest. Its long-planned objective as an essential element of Columbia Basin land reclamation was not entirely forgotten but was set for accomplishment at some vague future date.

Thus Grand Coulee started, in essence, as $63,000,000 worth of power development. Meanwhile politics and policy had injected another factor into the Northwest federal relief-works program. Oregon had demanded its share of relief works, and the Bonneville power and navigation dam on the lower Columbia River was given an allotment of $31,000,000. As Bonneville was nearer the power markets and also was alone capable of furnishing more power than the market required, a reconsideration of the original plan for Grand Coulee was indicated. There were other influencing conditions, which are stated with a full description of the revised plans in the following article. The net result is that today the base of the future irrigation dam is under construction.

CONSTRUCTION, begun under the original plans worked out to fit the $63,000,000 allotment, was not materially affected by the change. Instead of a low dam that would raise the water 150 ft., the change in plans called for construction at the same cost of the base section of a dam 540 ft. high, to raise the water level 350 ft. This is the dam planned for the full joint service of river and land improvement. When built to full height, it will serve the needs of river storage, irrigation development, power generation for irrigation pumping, and additional commercial power as it may be demanded. The base section now being built will have no present function except to assist regulation of the river's flow.

The change did not greatly alter the construction conditions or requirements; excavation volumes were increased some 2,000,000 cu.yd., concrete volumes were redistributed but not increased, and some additional refinements were introduced in placing the concrete. Virtually no changes were required in construction plant or plan or in the contractor's service provisions for the work. All these had been projected on a scale that comprehended any changes that might be made in plan and size of dam even to the completion of dam, power units and pumping plant to their full development for irrigation service. It is this broad conception of the construction task, and the resultant revolutionary construction attack on unusual volumes and conditions of this task, that sets the Grand Coulee Dam operations apart from the ordinary and warrants their description at the length represented in this issue.

In the construction attack, therefore, as well as in the controversial claims of power and irrigation and in the technical doubts of two-piece dam construction as first planned, the Grand Coulee Dam building operations are sensational. Nominally the operations involved only the tasks common to all dam construction: provision of access, housing and power service; river diversion for construction; removal of excavation for the dam emplacement, and production and placing of dam-structure concrete. But in all these operations the volumes were surprisingly large and the conditions unusual. The volumes are given in detail in the articles that follow. These great mass movements of material had to be carried on in a deep canyon, in the flood channel of a stream larger than the flow over Niagara Falls, and with available sources of concrete material and places of spoil disposal at a distance, high above the elevation of the work. The situation challenged inventiveness.

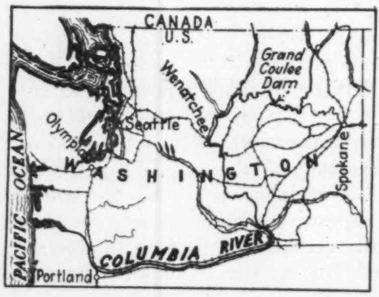
THE NATURE of the construction problem matches the extraordinary character of the site; the dry gorge of Grand Coulee, its floor six hundred feet above river level and extending southwestward from the present course of the Columbia for more than thirty miles, is the result of a most remarkable event in the world's history. That gorge was eroded by the waters of the river flowing over the rock plateau when a glacier blocked the course of the Columbia in the region of the Okanogan Valley, many miles to the west; when, later, the glacier retreated and allowed the river to resume its earlier course, Grand Coulee was left as a dry gorge, with a magnificent dry fall at its lower end. Its existence, however, is the reason for locating the Columbia River dam at its head, for by using the ancient gorge it is possible to carry irrigation water to the fertile plains to the south.

Conventional equipment and normal processes were, of course, available to the constructors and fully within their knowledge and experience. But while accustomed methods could have been made to serve, these men recognized in the peculiar conditions of the job a demand for approaching all operations as something to be devised anew. This approach did not look to new and strange devices but to an extension of existing devices to new horizons of application.

AFTER thorough study of local conditions the belt conveyor for spoil disposal was extended to greater lengths and adapted to different functions and conditions of service. So also the closure of the river by conventional cofferdamming processes was reduced to three steps by boldly enlarging the coffered areas by unusual application and installations of steel sheetpiling. This policy of original approach was manifested in individual details as well as general operations, an example being the ingenious conveyor system for filling the cofferdam cells.

Construction at Grand Coulee thus commands attention for the broad conception and brilliant attack by new methods of material movements of unprecedented magnitude in building masonry dams. Seven major articles in this issue describe the essential features of the operation and give data on volumes, plant and methods. It will be seen that these articles, while only a progress report, record the determinative introductory operations of great mass movements of excavation and concrete placement that will translate millions of money into physical structures for human service.

LOCATION MAP of Grand Coulee Dam, the Columbia River and the principal cities of Washington.



Grand Coulee Project and Dam

A review of the conditions that led to a radical change of plans with the details and quantities of the final structure

By Kenneth B. Keener
Senior Engineer, U. S. Bureau of Reclamation, Denver, Colo.

FUNDAMENTAL CHANGES have been made in the plans of Grand Coulee Dam since they were announced a year ago (*ENR*, Nov. 29, 1934), as a result of further study of the project. From the viewpoint of present construction the important change is in the dam design. In the original plan a low dam complete in itself was to be built, and later this structure was to be embodied in a higher and thicker structure. In the revised plan the high dam is to be built to full thickness but, under present contract, only to part height.

Columbia Basin project

The excellence of the irrigable land in the Big Bend of the Columbia River, from the point where it turns west near the Spokane Indian Reservation to the confluence of the Snake River, together with the large volume of water annually going to waste, has long been the impetus for investigations to determine the feasibility of an extensive development. The combined power and irrigation project as now conceived consists of the Grand Coulee Dam across the Columbia River, where it passes the northeasterly end of the well-known geological feature from which the dam has derived its name; a 1,890,000-kw. power plant; a 20-unit pumping plant in a 100x640-ft. building just upstream of the left abutment and below reservoir level, each unit of which will have a capacity of 800 sec.-ft. when operating under a total head of 370 ft.; plate-steel discharge pipes, one from each pumping unit, through which the water is raised to a supply canal 1.7 miles long; an earth and rockfill dam at each end of the Grand Coulee, to form a regulating reservoir about 23 miles long, the maximum water surface of which will be 280 ft. above that in the Columbia River Reservoir; an 11-mile main canal leading out of the southwesterly end of the Grand Coulee, having a capacity of 15,000 sec.-ft., which bifurcates into a main east and a main west canal, the former 156 miles long and the latter 101 miles, the entire main canal system requiring the construction of numerous large tunnels, siphons, wasteways, headgate structures and bridges; a distribution and lateral system extended to each 160-acre farm; secondary power plants at feasible locations along the canals, and transmission lines; numerous motor-driven pumping plants for raising the water not exceeding 100 ft. to various areas totaling 219,000 acres; and finally a drainage system to handle the seepage consequent to irrigation.

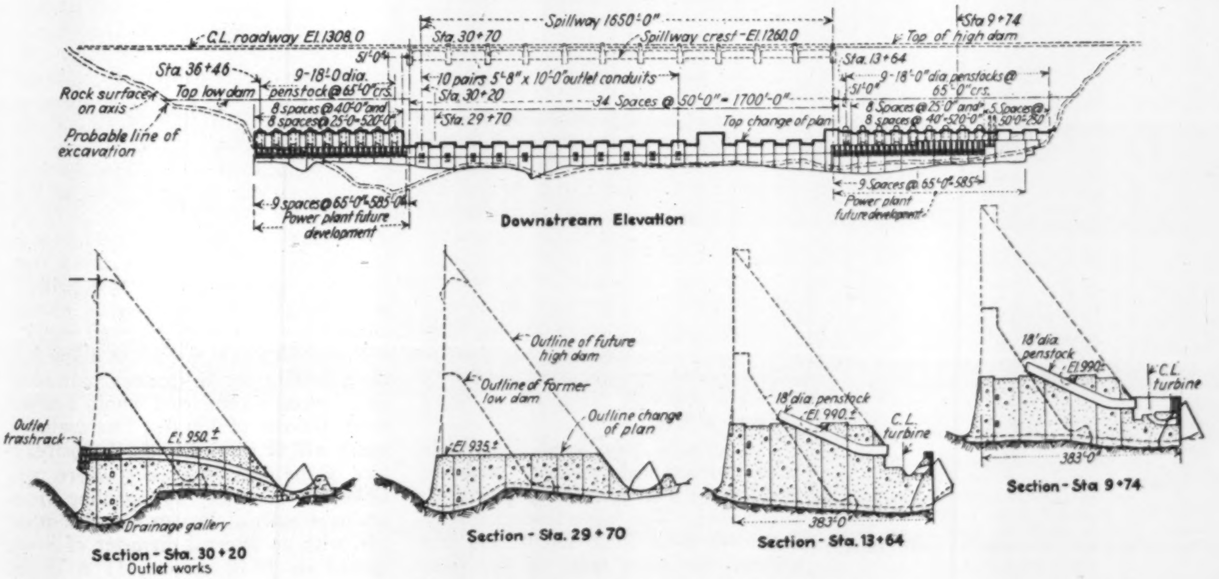
The project will embrace an irrigable area of 1,200,000 acres, extending 85 miles north from the southernmost point near Pasco, Wash., and having a maximum longitudinal dimension of 66 miles. The development of this desert region will be equivalent to adding another state the size of Delaware to the Union.

Of this huge project, only the Columbia River Dam is under construction, and not the full dam but only its base section. The upper part of the dam as well as the power plant, pumping plant, regulating reservoir and canals, await future authorization and financing.

Hydrology and soil conditions

The project is endowed with an excellent climate and a fertile soil, and when completed will have a more than ample water supply. The drainage area of 74,000 square miles upstream from the Grand Coulee Dam site embraces parts of British Columbia, Idaho, Montana and Washington. The river is fed largely by glaciers and melting snow, which, together with the large number of lakes serving as natural regulating reservoirs within the watershed, results in a runoff that, contrary to the flow of most rivers, is heavy during the summer months when most needed for irrigation. From 1913 to

GRAND COULEE DAM revised plan, showing high dam as now being built to part-height and as planned for completion. Original low dam shown in comparison.


Downstream Elevation

Section - Sta. 30+20
Outlet works

Section - Sta. 29+70

Section - Sta. 13+64

Section - Sta 9+74
C.L. roadway El. 1308.0
Spillway 1650'-0"
Sta. 30+70
Spillway crest - El. 1260.0
Sta 9+74
Top of high dam
51'-0"
Sta. 36+46
9-18'-0 dia. penstock @ 65'-0" crs.
Rock surface on axis
Top low dam
8 spaces @ 40'-0" and 8 spaces @ 25'-0" = 520'-0"
Probable line of excavation
10 pairs 5'-8" x 10'-0" outlet conduits
Sta. 30+20
Sta. 29+70
34 Spaces @ 50'-0" = 1700'-0"
Top change of plan
Sta. 13+64
9-18'-0" dia. penstocks @ 65'-0" crs.
51'-0"
8 Spaces @ 25'-0" and 8 spaces @ 40' = 520'-0"
5 Spaces @ 50'-0" = 250'
9 spaces @ 65'-0" = 585'-0"
Power plant future development
9 Spaces @ 65'-0" = 585'
Power plant future development
Outlet trashrack
El. 950.±
Drainage gallery
Outline of future high dam
Outline of former low dam
Outline change of plan
El. 935.±
18' dia. penstock
El. 990.±
C.L. turbine
383'-0"
18' dia. penstock
El. 990±
C.L. turbine
383'-0"

1931 the flow at Grand Coulee varied from 17,000 to 492,000 sec.-ft., the average being 109,000 sec.-ft., amounting to an average annual runoff of 79,000,000 acre-ft. The estimated irrigation requirement is 3.25 acre-ft. per acre, corresponding to a total annual requirement of 3,900,000 acre-ft. for 1,200,000 acres, or only 1/20 of what the river could supply.

The mean annual temperature of the project is 50.4 deg. F., and during the irrigation season from April to October it is 62.2 deg. F., which period is generally characterized by hot days and cool nights. The average frost-free period is 159 days. The mean annual precipitation is 8.2 in., but the mean for the irrigation season is only 3.6 in.

The soil is generally deep and varies from fine silty loam to sandy loam. There are small areas of sandy soil underlain with gravel. In 1911 the Bureau of Soils of the Department of Agriculture after a partial survey reported the soil to be extremely rich, stating that, if irrigated, it would be productive. The crops will be any or all of those common to a temperate zone, such as hay, grain, beans, peas, other vegetables and fruits.

PRINCIPAL QUANTITIES,
GRAND COULEE DAM

	Original Low Dam	Ultimate High Dam	Present Dam Base
Excavation, cu.yd.			
Common ..	11,000,000	14,600,000	14,487,000
Rock	800,000	800,000	800,000
Concrete, cu.yd.			
Mass	3,100,000	9,250,000	3,960,000
Total	3,600,000	10,000,000	4,070,000
Metal, lb. ...		242,000,000	50,700,000
Cost	$63,000,000	$178,000,000	$63,000,000
MWAK, bid	*$29,339,302		†$29,339,302

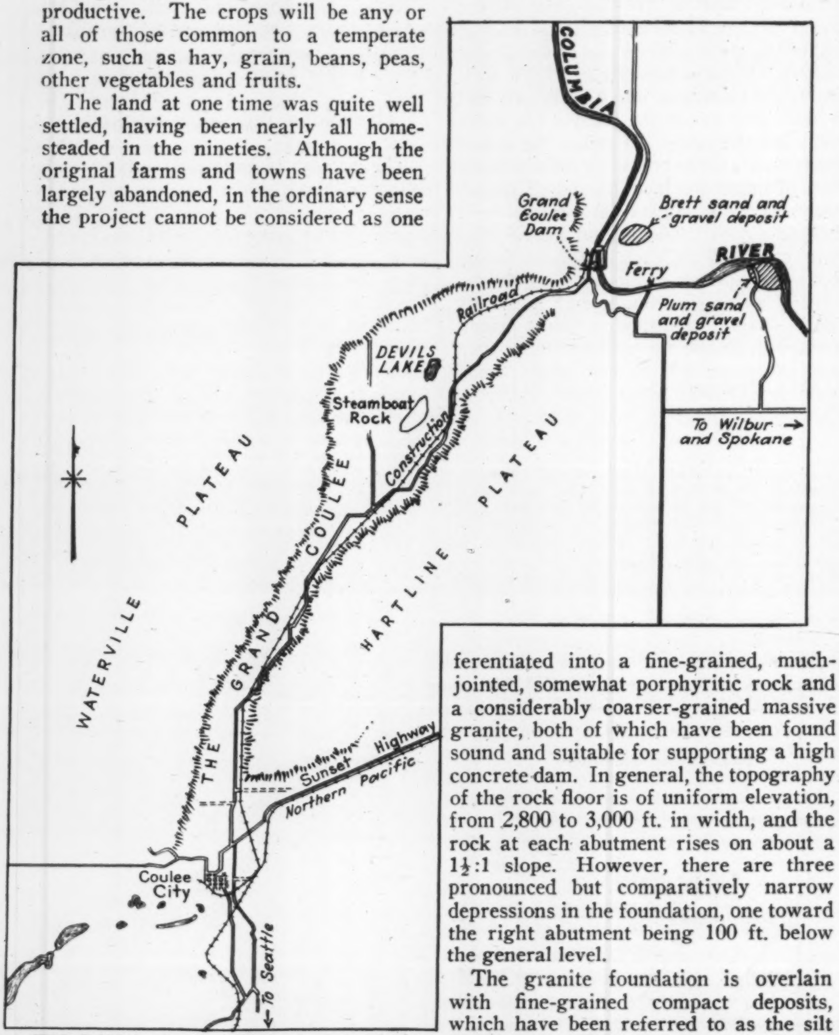
*On certain specified quantities.
† Subject to adjustment.

Note: Figures do not include auxiliary contracts (preliminary grading, about 3,000,000 cu.yd.; railroad and highway construction; bridge across Columbia River, government town).

The land at one time was quite well settled, having been nearly all homesteaded in the nineties. Although the original farms and towns have been largely abandoned, in the ordinary sense the project cannot be considered as one bringing new land into cultivation. During years of heavy precipitation good crops of wheat were raised, but dry years became so frequent that the majority of the settlers were forced to leave. However, at the present time about a third of the project is devoted to raising grain in large tracts.

Grand Coulee Dam site

The foundation and abutment bedrock is entirely granite, which may be differentiated into a fine-grained, much-jointed, somewhat porphyritic rock and a considerably coarser-grained massive granite, both of which have been found sound and suitable for supporting a high concrete dam. In general, the topography of the rock floor is of uniform elevation, from 2,800 to 3,000 ft. in width, and the rock at each abutment rises on about a 1½:1 slope. However, there are three pronounced but comparatively narrow depressions in the foundation, one toward the right abutment being 100 ft. below the general level.



THE DAM is placed at the head of the Grand Coulee, through which the river flowed southwestward in glacial times when its normal channel was blocked by ice.

The granite foundation is overlain with fine-grained compact deposits, which have been referred to as the silt overburden. This has a thickness varying from about 20 to 150 ft. and constitutes the main mass of the foundation excavation, the removal and disposal of which constitute one of the major construction problems. Occasional strata of small gravel occur, and a thin layer of till and debris overlies.

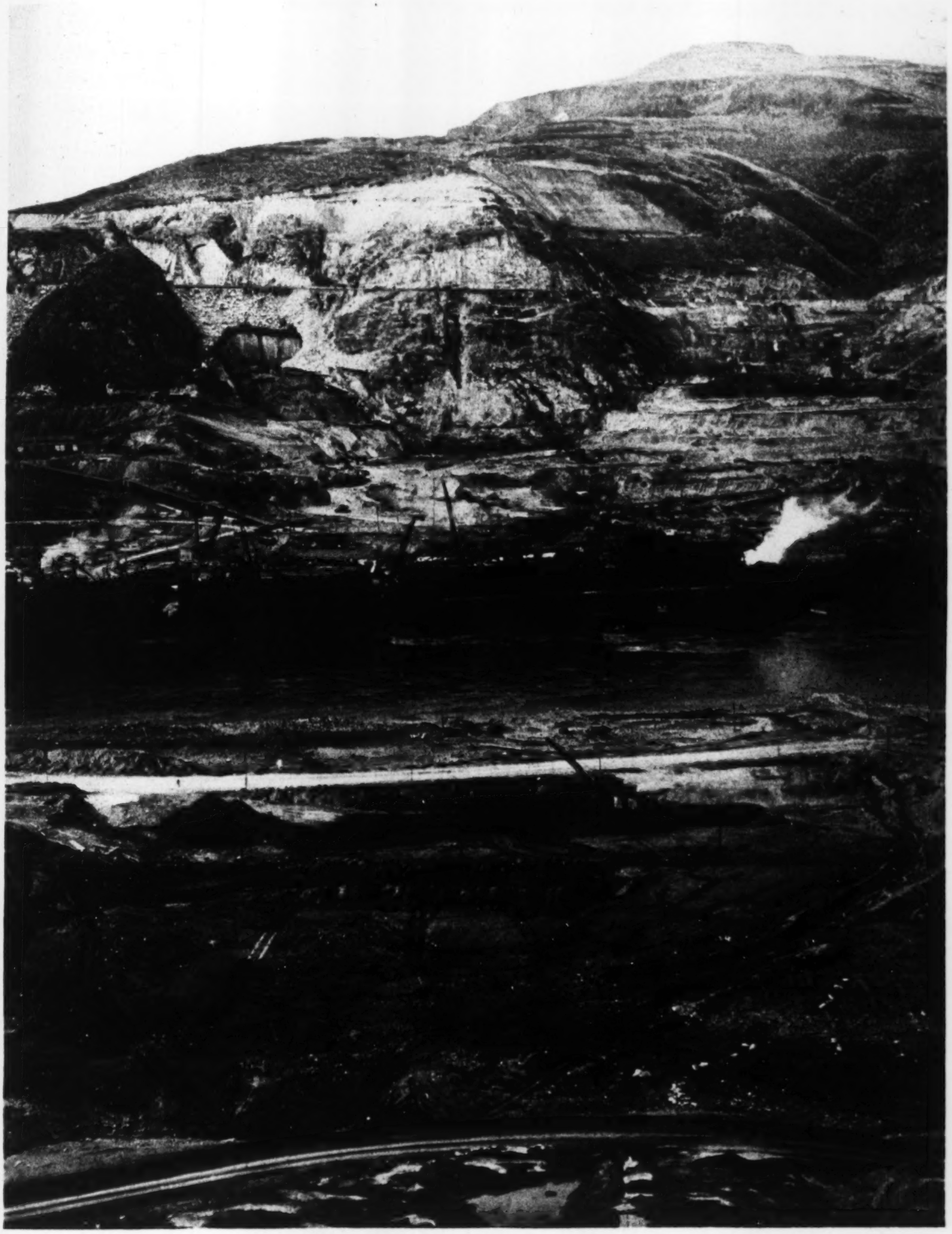
Early field investigations of the dam site consisted of fourteen diamond-drill holes in 1921 and two additional holes in 1930. A more thorough investigation of the site was begun in the fall of 1933 and, although construction is in progress, the drilling is being continued to solve various design and construction problems prior to the completion of the excavation. Some of the holes have been carried to great depths, one having been drilled 657 ft. below the bottom of the river channel.

Proposed high dam

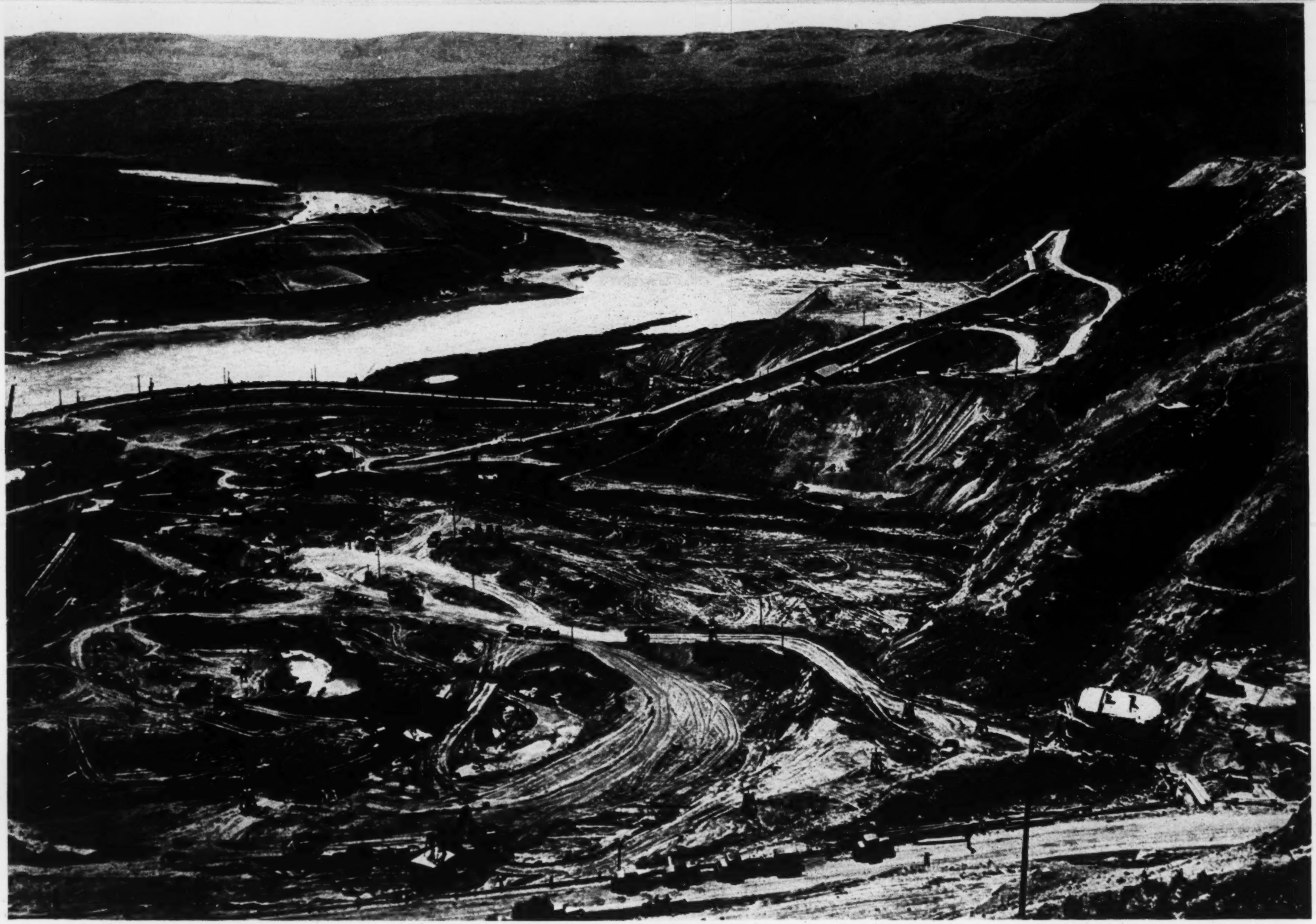
The high dam, whose base is now being built, will be of the massive-concrete, straight-gravity type, consisting of a river-overflow section, 1,650 ft. long, and abutment sections. The dam will have a maximum height of about 540 ft., to raise the water surface 350 ft., a top length of 4,100 ft. and a top width of 30 ft. Parapet walls 3½ ft. high will run the full length of the outer edges of the top of the abutment sections, enclosing a 26-ft. roadway that will be carried across the spillway by an eleven-span bridge. The toe of the spillway section will be extended, to form a trough or bucket to reduce the velocity of the falling sheet of water and prevent undercutting.

To control the contraction of such a large mass of concrete, the dam will be constructed with vertical transverse and longitudinal contraction joints, so formed that the resulting rectangular blocks or columns will be keyed together. The joints will be provided with a pipe and outlet box grouting system, and metal grout stops will be installed across the joints near the faces of the dam, the grout to be applied under pressure after the concrete has been cooled to its future average temperature. The temperature of the concrete will be reduced by running water of low temperature through coils of 1-in. metal tubing embedded in the concrete at 5-ft. 9-in. horizontal and 5-ft. vertical spacing.

The foundation rock below the heel of the dam will be grouted under low pressure for a width of at least 60 ft. and a depth of 20 ft. before concrete is placed, and a high-pressure grout curtain to a depth of about 100 ft. will be provided after the concrete is placed. Drain holes 50 ft. deep, 10 ft. on centers, will be drilled in a single row a few feet downstream from the grout curtain after all grouting is completed within a minimum distance of 150 ft. The drainage water will be carried to the downstream face of the dam by gravity where possible, but generally by pumping from drainage sumps. Porous concrete drain tile, with an internal diameter of 5 in., spaced on 10-ft. centers, 11 ft. 9 in.



First cofferdam, on west bank of the Columbia, built of 13,000 tons of 80 ft. steel sheetpiles and 400,000 cu.yd. of fill and backing material



Excavation operations in west cofferdam area involving power shovels, trucks, tractors and belt conveyors from the upstream face will provide drainage for the dam concrete.

Large spillway capacity

The spillway will be divided into eleven 135-ft. openings by ten piers, and structural-steel drum gates 28 ft. high will be mounted on the crest in these openings. The lip of the drum gates when fully raised, at El. 1288 (low water in the river at present is about El. 940) will control the normal high-water surface in the reservoir, which at this elevation will have a capacity of 9,610,000 acre-ft. in a lake extending 151 miles to the Canadian border. The spillway capacity with gates down and a reservoir water-surface elevation of 1290.5 will be about 1,000,000 sec.-ft., slightly more than twice the recorded flood.

The outlet works comprise twenty 8½-ft. conduits through the spillway of the dam, discharging into the spillway bucket. The flow will be controlled by a ring-follower and a paradox gate installed in tandem in the upstream end of each conduit. The outlet works will be protected by semi-circular reinforced-concrete trash-rack structures, built on the upstream face of the dam, one structure serving for two outlets. The capacity of all outlets under full reservoir head will be 150,000 sec-ft.

The power plant, with a total capacity of 2,550,000 hp. when completed, will consist of nine equal units, located immediately downstream from the river ends of the abutment sections, on each side of the river. The power penstocks of heavy plate steel and an internal diameter of 18 ft. will be embedded in the mass concrete of the dam. In addition to the above, it is planned to install two small service units adjacent to the west power plant.

The dam and power plant have been estimated to cost some $170,000,000. The irrigation works would cost about $210,000,000 in addition. Economic studies led to the conclusion that power revenues would return the cost of the dam and power plant and half the cost of the irrigation works.

The original low dam

Two years ago, when the $3,300,000,000 public-works fund provided by the Recovery Act of 1933 was to be put to work, an allocation of money was made to begin work on the dam. This allocation was limited to $63,000,000, or only about one-third the cost of the dam and power plant just described. Accordingly, a low dam was designed, to constitute the first stage of a two-stage construction program, but to produce a complete operative power development, without waiting for the second stage. This low dam, proportioned to the available funds, was of a height that would raise the river level 150 ft.

DIRECTION OF WORK

The Grand Coulee project is being built by the U. S. Bureau of Reclamation, Dr. Elwood Mead, commissioner, and R. F. Walter, chief engineer. F. A. Banks is project engineer and is assisted by James H. Miner, office engineer, and Allan F. Darland, field engineer.

The general contract for the Grand Coulee low dam, which was awarded on a bid of $29,339,300, is held by the M.W.A.K. Co., formed for the purpose of bidding this job by Silas Mason Co., Inc., New York; Walsh Construction Co., Davenport, Iowa, and Atkinson-Kier Co., San Francisco. Officials of the M.W.A.K. Co. are Silas B. Mason, chairman of the board; T. J. Walsh, president; Guy F. Atkinson and M. J. Whitson, vice-presidents; W. A. Hanger, treasurer; and E. L. Kier, secretary. H. L. Myer is general manager, Francis Donaldson is chief engineer, and M. H. Slocum is general superintendent.

After extensive preparatory excavation, a contract for the construction of the low dam was entered into on July 16, 1934. The contract called for the construction of a concrete straight-gravity dam, having a height 192 ft. less than that of the high dam and a total top length of about 3,600 ft. The dam was so located that the upstream face of the low dam would later be a part of that face of the high dam. As this dam did not have an unusual thickness, being only about 260 ft. thick at maximum section near the foundation, no plans were made for artificially cooling the mass concrete. An uncontrolled overflow spillway, 1,800 ft. long, was provided for in the river section, which was to be extended at the toe to form a bucket similar to that planned for the high dam. Intentionally, no provision was made for bridging the spillway. Downstream from the left abutment, the west end of the future power house on that side of the river was to be completed for the installation of three main generating units and two service units. All penstocks, with the downstream ends temporarily capped, were to be embedded in the dam for the future power units. The contract also included the main portion of the excavation for the high dam and the construction of a permanent downstream cofferdam, which would later form a part of the toe of the high dam and the downstream portions of the future powerhouses.

This "low dam" required about 3,500,000 yd. of concrete, or one-third as much as the high dam, but about the same amount of excavation.

Certain objectionable construction features were involved in building the high dam in two stages. One of these was the joint between the low dam and the additional mass concrete in enlarging it to the high dam, which would require exceptional care in both design and construction to prevent the accumulation of dangerous hydrostatic pressure; and another was the uneconomical accommodation of the hydraulic machinery in the power plant to the low and high-head conditions.

Change of plan

The plan of the Grand Coulee development contemplated only a power project. It was thought that if it should be later decided to have a combined power and irrigation development, this could be accomplished by increasing the size of the original dam. Upon further study of the effect of imposing a high dam upon the low dam, the engineers of the bureau reached the conclusion that a change in the size and shape of the foundation, to make possible the ultimate construction of a high dam needed in irrigation, should be made now.

The official order for this change of plan to the contractor was issued on June 5, 1935. Roughly, the principal changes involved are: (1) mass concrete that was originally planned to be placed in the top 125 or 150 ft. of the low dam will now be placed in the lower and downstream portions of the high dam; (2) vertical longitudinal contraction joints, spaced 50 ft., will be provided in the mass concrete of the dam; (3) metal tubing will be embedded in the mass concrete for artificial cooling; (4) the permanent cofferdam downstream from the spillway will be eliminated, and the designs for the permanent cofferdams downstream from the future power plants will be revised; (5) all powerhouse construction above the level of the turbine floor will be eliminated, and no machinery will be installed; (6) the power penstock structures will be eliminated; (7) the tailrace for the east power plant will be excavated; and (8) the common excavation for the foundations will be increased by about 2,000,000 cu.yd.

Despite the fundamental character of the change, shown graphically by the accompanying drawings, it has little effect on the construction operations. Cofferdam construction and excavation for the main foundation are unaffected, and the added tailrace and foundation work fits readily into the contractor's program of operations. Details of the concreting procedure will of course be modified by the reduction in height of the dam and the introduction of block concreting and cooling and grouting systems.

Completion of the Grand Coulee high dam is a problem for the future and one that need not be given serious consideration until the work now under contract is nearing completion. Conditions and requirements at that time will no doubt govern the next step to be taken in the development of the Columbia Basin project.

Ten Months' Construction Progress

A CITY of 3,000 PEOPLE who have been assembled to build the great dam at Grand Coulee on the Columbia River. Coulee Dam, the government settlement, is in the foreground; Mason City, the contractors' camp, lies across the river.

Plant and services for Grand Coulee Dam are virtually completed, including cofferdam for half of the work—Stripping of the foundation bed is so far advanced that concreting can begin at end of first construction year

THE FIRST and also the lasting impression which the visitor gets at the site of the Grand Coulee Dam on the Columbia River in Washington is of an earthmoving job of tremendous size. A number of independent earthmoving operations, each of huge dimensions, are under way simultaneously.

Behind the protection of an earth dike on the east side of the river and within the enormous cofferdam that has been completed on the west side (the river flows north at this point) excavation has been advanced well below water level, and material now is moving rapidly to the spoil banks. On the east side the movement at present is by trucks to a waste area 4,000 ft. upstream; later, conveyor transport to the open west-bank main conveyor is expected to eliminate the trucking. Since May 28, when high water flooded the bottom, excavation has been from elevations above the river surface. On the west bank a mile-long series of belt conveyors 5 ft. wide pours a steady stream of material excavated from within the cofferdam onto a deep canyon. High up on the steep hillside above the west end of the dam site, a slide dislodged more than 2,000,000 cu.yd. last year; here much of the loosened material has been hauled away and the slopes are being trimmed. Altogether, by Aug. 1, about half of the 15,400,000 cu.yd. of excavation involved in the general contract had been moved.

The general plan of attack is to unwater the two shore ends of the dam site by cofferdams and excavate to bedrock behind them on both sides of the river, leaving the river channel for final closure. The west cofferdam, the first, was largely driven last winter and was completed during the low-water season this spring; foundation concrete on the west end is to be placed this winter, starting by Oct. 1. The east cofferdam also will be under construction this winter; its river wall will be parallel to and 720 ft. distant from the river wall of the west cofferdam, thus leaving an open river channel for floodflow of the Columbia. Probably during the winter of 1936-37 streamflow will be diverted from this central channel and passed over foundation concrete near the west end of the dam. The river channel then is to be unwatered, excavated to bedrock, and the central portion of the dam concreted.

Before and since the contractors were given formal notice to proceed (Sept. 25, 1934), much more than work on the dam site itself has been undertaken. The Columbia had to be bridged, first with a temporary pile trestle bridge and then with a permanent construction bridge;

a water supply had to be developed, a city built, a construction program planned and plant assembled. Much of the work was done on rush schedule, as in building a 110,000-volt transmission line 31 miles long in 42 days. Much of the work, too, had to be done under difficulties, such as cofferdam construction at maximum speed during subzero weather. A factor in all these operations has been the 32-mile truck haul in winter months. A 30½-mile railroad from Coulee City to the dam, which is to be the main supply line, is now in service.

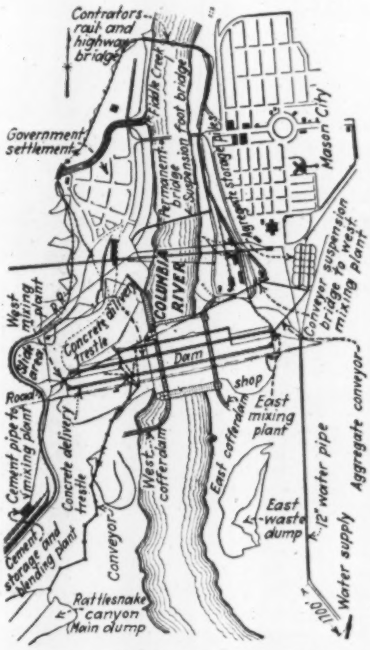
Housing the job forces

On the west bank, a short way downstream from the dam site, a group of permanent buildings is under construction for the use of government employees. This settlement is known officially as Coulee Dam. Here are ample evidences of plans for permanent habitation, paved streets, concrete sidewalks and lesser structures generously spaced on the broad slope toward the river from the U.S.B.R. Administration Building, which dominates the west bank of the river. Topsoil is being hauled in ample quantities to make the new little city a garden spot.

From the government's side of the river one obtains an excellent view of the settlement on the opposite side, which is the domain of the contractor. Unlike the ordinary contractor's-camp buildings, the houses in Mason City are all neatly painted. Many have attractive little gardens. They are grouped in orderly rows about Mead Circle, centrally located near the main buildings and separating the private homes from the men's dormitories. Comfortable housing facilities for 2,100 people with bank, postoffice, city hall, a very large general store, theater, hospital, churches, ball park, airport and other elements of modern community life justify the title "city." Unlike most cities, however, Mason City has every house occupied, and there is a waiting list of would-be tenants.

Record speed of construction, typical of the entire job, was achieved also in building Mason City. Construction was started Oct. 14, 1934, and before the end of the year it was 85 per cent complete. All construction is of a quality to meet modern home requirements; foundations are of concrete blocks, and interiors are finished in a panelboard for which insulating qualities superior to plaster are claimed. No chimneys were needed because all cooking and heating is done by electricity. Heating equipment is designed to be adequate at temperatures as low as 20 deg. below zero.

The water supply, taken from the Columbia River above the dam, is chlorinated and pumped to tanks on the hill above the town. Large supply mains, plus a paid fire department, resulted in low insurance rates. Sewage is treated in an Imhoff tank of 600,000-gal. daily capacity, whose effluent is discharged into the Columbia below the city.



LOCATION MAP of Grand Coulee Dam and of essential construction plant and servicing units mobilized to build this great irrigation and power-development works.

In the married quarters there are three classes of houses, all on 60x80-ft. lots, with a four-compartment garage to every four houses. Because of the large number of newlywed couples that have come to this job there has been very great demand for the Class A or one-room cottages, of which only 64 were built. The Class B cottages, somewhat larger, are next in popularity; of these there are 128. Of the Class C type houses, which have two bedrooms, 88 were built. The rental rates on the cottages range from $18 to $38 per month including water. Electrical energy is metered, and householders pay at a low rate.

Accommodations for 1,200 men are provided in electrically heated cabins of twelve rooms in which each room has beds for two men, and in eight-room cabins provided with bath and toilet facilities. Bath houses are centrally located in each group of cabins.

Ten platforms for eight additional housing units provide emergency capacity. Exclusive of tent occupants the total city population is about 2,100. At the peak of employment thus far (Feb. 28) the M.W.A.K. Co. had 2,681 on the payroll. Those not resident in Mason City come from settlements that have sprung up quickly just outside the area which the government has reserved. Most of these have typical boom-town characteristics. Near-by settlements include Coulee Center, Elmore Heights, Grand Coulee, Electric City, Rimrock and Elmerton. The total population now living in the Grand Coulee vicinity is estimated at ten to twelve thousand.

Mason City houses and facilities may become the property of the government when the present contractor finishes his work. That is, if the government elects, it may purchase for $25,000 all buildings and installed utilities such as sewer, water, electrical services, etc. If the government elects not to purchase at this price, the contractor may be required to remove at his own expense all structures at Mason City "except churches and eleemosynary institutions."

A provision in the contract giving the government an option to purchase at a stipulated price also applies to two other items: (1) the 30-mile, 110,000-volt transmission line, on which the option price is $25,000; and (2) the entire installation of construction equipment, including crushing, screening, washing, concrete mixing, conveying and other installed facilities, but not including draglines, tractors, trucks, shovels or other mobile equipment. The option price on the construction plant is $100,000.

Bridging the Columbia

The government's permanent bridge, located about half a mile below the dam site, will be a steel cantilever structure with a central span of 550 ft. (*ENR*, Oct. 25, 1934, p. 519). Difficulties attendant upon getting the piers down to bedrock delayed the bridge contract for several months. Pneumatic caissons finally were used, and the piers are practically completed.

Meantime the M.W.A.K. Co. has built a temporary trestle and a construction bridge. The first to be built was a pile trestle 672 ft. long, and in the light of later developments it is of interest to observe that this was carried on five-pile bents 16 ft. on centers carrying four 9x18-in. stringers, to which were spiked 6x8-in. timbers laid edgewise face to face, to serve as flooring.

This temporary structure was not intended to withstand floods or ice jams. An ice jam lodged against it on Jan. 20, however, and under the pressure of moving ice floes the bents swayed and jerked enough to pull the drift bolts entirely out of the caps in some cases. After it had been buffeted by the ice, it was strengthened, the deck was lashed to cables, and it was again put in service for general traffic, carrying heavy buses and equipment weighing up to 20 tons or more.

The contractor's combination railway and highway bridge was completed and opened for traffic on March 31, and the trestle bridge was removed a short time thereafter, in advance of high water. A barge derrick did the work in a day and a half, salvaging all timbers and piling. The bridge was built in fourteen days at a time when the streamflow was 50,000 sec.-ft.

When the ice jam came and safety of the trestle bridge was threatened, construction of a light footbridge—a

THE SLIDE AT GRAND COULEE that placed 2,000,000 cu. yd. of earth across the road and railway locations that give access to the dam operations.

catwalk or suspension bridge of 770-ft. span—was begun immediately, and the bridge was put in service within four days. It has since been relocated farther downstream and at a higher level, to make it serviceable during the highest floods.

The bridge on which the contractor has placed most dependence is a timber structure that spans the river with four Howe deck trusses, each 152 ft. long. Approach spans at each end are carried on six 36-in. I-beams 70 ft. long. The three channel piers consist of steel sheetpile cells filled with gravel and having interior H-beam bearing piles capped with 5 ft. of concrete at the ice line. Structural-steel bents resting on the capping support the trusses. The bridge is 30 ft. wide and accommodates railroad, roadway and a walk. It was opened to traffic March 31 and is expected to serve the contractor throughout the job. As it is a high-level bridge, it is nearly as convenient as the permanent government bridge now being built a few hundred feet upstream.

Steel sheetpiling, which constituted the heaviest tonnage during the earlier months of the job, fortunately did not have to cross the river but was delivered to the cofferdam on the west side, which is the terminus of the 32-mile road from the railroad at Coulee City. During the winter and early spring some 13,000 tons of this sheetpiling was trucked from the railroad for use in the construction of the cofferdam.

The slide problem

Slopes as flat as 1 on 2 are found not to be stable in some parts of a great slide area at the west abutment of the dam. As it is through these areas that railway and highway communication with the job must be maintained, attention has been concentrated on stabilizing these slopes. Changing formations with occasional seams of soft clay are believed to be the reason for the unusual tendency to slippage. Some of the early slides are believed to have squeezed out clay, which lubricates the plane where slippage occurs.

Half a dozen drainage wells that were put down in the slide area were carried away by slides. Then a system was laid out depending upon shafts and drainage tunnels in rock, which drained the lower portions of the drainage wells. The first of the shafts, 4½x8 ft. in plan and 273 ft. deep, is sunk in a rocky point beside the main slide. A drift 192 ft. long from this shaft runs in rock to the bottom of one drainage well and from there tees to two other wells, thus intersecting the bottoms of three drainage wells. Observations of the effect on these wells of pumping down other wells near by had previously given indication of the location and the extent of the waterbearing areas.

The major slide, which occurred Nov. 15, 1934, is estimated to have moved more than 2,000,000 cu.yd. Most of the material moved to lessen the burden on this slide area was hauled away in motor trucks over the main access roadway to the government townsite. Several contracts have been let on slide removal at prices ranging from 43 down to 26c. per cu.yd. The main slide and a small one to the south have interfered somewhat with the contractor's schedule of excavation in removing material from the cofferdam by belt conveyor.

Fortunately, the main slide is in a ravine whose rock walls converge in the lower end toward a narrow pass called the plug. Thus there is more stability than would be afforded if the ravine widened in the usual way. The long slope above the railroad grade has been smoothly trimmed to a 1-on-2 angle, but on this same slope below the road some additional slippage was noted late in May, after most of the area had been trimmed. Most of the excavation had been removed from the slide area by the middle of June.

Excavation at the dam site

Excavation of the east end of the dam site under a subcontract began Feb. 21, 1935, with two 2-cu.yd. and one 1½-cu.yd. power shovels serving 24 motor trucks. Originally a belt-conveyor system was contemplated for use on this end of the dam, similar to the long conveyor now employed on the west end. On the east end, however, because of the short haul and the ease with which a truck road could be built, the conveyor idea was not applied at first. Instead a 50-ft. roadway was located on a uniform 5 per cent grade and surfaced with about 18 in. of gravel. Over this roadway for several months a fleet of trucks has been hauling material from the excavation about 4,500 ft. upstream to the spoil bank. Excavation by this means averages about 10,000 cu.yd. per day.

During the low-water season just past, excavation on the east end was carried on without the need of a cofferdam. When the excavation went below river level and pending the arrival of high water, protection was afforded by a wide dike of material left in place immediately along the river bank. When water covered this dike and flooded the lower excavation, operations were moved to higher ground to the east. When the east cofferdam is built, the lower excavation will be resumed. It is expected that the methods of building the east cofferdam will be similar to those used on the west cofferdam.

On the west side of the river excavation the M.W.A.K. Co. started on Oct. 4, using 1½- and 2-cu.yd. shovels, loading 8- and 12-cu.yd. dump trucks. Pending installation of the belt-conveyor system, the trucks hauled to temporary dumps in and adjacent to the government townsite.

Construction of the cofferdam was carried on under the pressure of haste because it was necessary to complete it before the season in which the Columbia River usually is in flood; sometimes high water begins early in April. Despite difficulties of extremely hard bottom and cold weather, remarkable speed was made in driving the 667,000 lin.-ft. of steel sheetpiling used in the west cofferdam, and work was completed early in April. Since Dec. 17 of last year excavation has been removed from within the cofferdam area by the conveyor-belt system: the surface of the excavation went below water level soon after completion of the cofferdam.

Power shovels, dump trucks, tractor wagons and conveyor systems will be primary factors in excavation throughout the job. Despite the fact that the belt will be used for the long haul (probably from the central and east cofferdams as well as from the one on the west side), shovels, dump wagons and trucks always will be depended upon for actual excavation and delivery to the belt.

Seven-hour shifts

A notable feature of the work under the M.W.A.K. contract is the 21-hour day, consisting of three 7-hour shifts. This has several advantages. Three are cited by the contractor as most important: (1) the idle interval of one hour between shifts makes it possible to familiarize the foreman of the oncoming shift with whatever conditions have developed during the preceding shift; in this time the two foremen go over the work together and develop any ideas they may have for improving methods or speed; (2) opportunity is afforded all operators of machinery to oil and inspect working parts and to do such maintenance or minor repair work as will be sure to keep the equipment in working order; and (3) in any emergency the entire crew can be kept at work during this additional hour without any claim for overtime and without exceeding the labor-limit stipulations on a PWA job.

AFTER GRAND COULEE EARTHSLIDE had been cleared away and drained and the hillside sloped smoothly to a safe angle, the road and railway grades were developed.

Aggregate and cement handling

Although the first concrete is not scheduled to be placed until October, much work has been done in planning and laying out construction equipment for getting out concrete aggregate, handling bulk cement and mixing and delivering concrete. Contract has been awarded for ten 5,000-bbl. steel cement silos to be built near the railroad on the west side of the river. Eight of these silos will be used for cement as delivered from the manufacturers, and two will store blended cement. Mixer plants, each with four 4-cu.yd. mixers, will be installed in duplicate on each side of the river. All cement blending will be done on the west side of the river, just as all aggregates will be prepared on the east side. A suspension bridge will connect the two mixing plants; over the bridge, aggregate will move westward on a conveyor, and bulk cement will move eastward in a pipe.

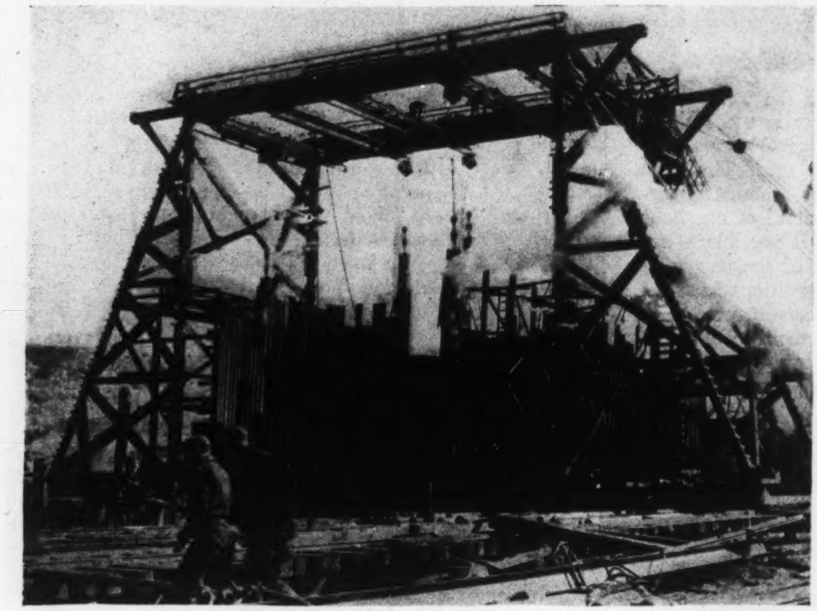
The concreting plant as a whole is being laid out with the care warranted by a task of placing 3,500,000 cu.yd. If the present contract is supplemented by another providing for the high dam, the concrete total will be 10,000,000 cu.yd., or more than twice as much as went into Boulder Dam. To allow time for tuning up, it is planned to have the plant for delivering sand and gravel ready for service in September. Aggregate is to come from the Brett Banks, 1½ miles northeast of the dam on a high mesa that forms the eastern edge of the Columbia River Canyon. Here a glacial deposit contains all necessary sizes in quantities far exceeding the needs of this job. However, some 5 ft. of overburden must be removed, and indications are that the materials are not of uniform character; lenses of fine material occur frequently enough to necessitate wasting large quantities of fines.

The specifications call for four sizes of gravel, with 6 in. as the maximum. Sand will be graded by classifiers into three sizes, later to be blended through proportional feeders and mixing equipment. The screening and washing plant is designed for a capacity of 1,000 tons per hour. At continuous maximum capacity the combined delivery from the two mixing plants is to be 640 cu.yd. per hour.

Preparing the emplacements for the shore sections of the dam, by laying dry the east and west thirds of the river channel by large steel-pile cofferdams, is outlined in the next article, with a full description of the west cofferdam construction.

STACKER UNIT of spoil conveyor mounted on crawler treads so that 175-ft. boom can be swung through an arc of 180 deg. to spread the spoil.

Constructing the First Cofferdam



TIMBER GANTRY with four steam hammers suspended from electric hoists; suspension arrangement permits spotting hammers over any point in the area beneath the gantry frame.

Subzero weather and hard driving at Grand Coulee magnified a sheetpiling operation that had to be completed before spring high water—Speed attained with a gantry crane carrying four piledrivers

CONSTRUCTION at the Grand Coulee Dam site got off to a late start in the winter (1934), which is low-water season on the Columbia River, and effort was concentrated on getting the first cofferdam completed before high water, which usually begins in April. The first cofferdam is on the west side of the main river channel, has a total length of 3,000 ft. and consists of several sections of different design, but virtually all was steel sheetpile construction. The major operation in building the cofferdam was, then, the driving of 13,000 tons of steel sheetpiling, involving a total of 667,000 lin.-ft. This presented unusual difficulties because of the extremely hard material to be penetrated.

The first steel pile was driven on Jan. 1. For two or three weeks the work did not attain full speed. Progress was retarded by prolonged subzero weather, but the major difficulty was the extremely hard driving. Means of expediting the work were urgently needed. This need was met by building a gantry crane to span the cofferdam cells, equipping it to handle four or more steam hammers and thus multiplying the rate of driving. The greater portion of the driving was then completed in a 60-day period, and all steel piling in the cofferdam was in place on April 10.

The difficult driving, which made it impracticable to attain the expected penetration on the river side, led to changing the design somewhat. How these changes have developed into the final plan; how a shuttle conveyor 870 ft. long was used for filling the cells of the cofferdam, and other unusual features of the job are described here.

Cofferdam design

Geological reports give assurance that a solid granite of excellent quality underlies the entire dam site. Because of the curve in the river just above the dam site, and the topography of bedrock and of the main river channel, it seemed desirable to unwater the west end of the foundation first. The simplest form of cofferdam to accomplish this purpose was one with its mid-portion parallel to the river channel and both ends curved into the west bank. These considerations and the development of the best plan to meet them were primarily the concern of the contractor. The general contract for the dam leaves these problems to the contractor by calling for a lump-sum bid on the item covering "diversion and care of the river."

Four different types of construction were used in different parts of the cofferdam, as shown by the accompanying plan. Sections B and I consist of a single line of interlocking steel piling along the front face, driven to refusal and carried up to El. 900 (low-water elevation about 940), and a rear wall of timber, 37 ft. back, attached to the front face by tierods. Section H is made up of uniform cells 90x36 ft. in plan with an arc of 36-ft. radius at each end of the cell. These cells were made extra wide because the tailrace excavation will have to be taken out inside the cofferdam at this point, and these coffers will have to have stability without the aid of a berm. Sections C and E are similar to H but have cells 40x50 ft. in plan with faces on 40-ft. radius.

Section F, the inside face of the berm behind the river section, E, is a single line of sheetpiling connecting the two cell clusters. The two cell clusters D and G also have arcs of 40-ft. radius. The diaphragms are of steel piling only up to El. 965; from that level up to El.

990 tierods take the place of diaphragms. These cell clusters have a two-fold purpose; they serve as a three-way connection, joining first to the closure of the west area and later, when the west end becomes the bypass channel, they will tie into the cross-river cofferdam. When the east cofferdam is constructed, its river face will be *720* ft. from the river face of the west cofferdam.

Core borings at the dam site showed the granite foundation to be overlain by a thick blanket—ranging from 60 to 80 ft. in depth—of hard, compact material commonly called clay or "young shale." On top of this blanket is an overburden of basalt fragments and boulders. The young shale is more accurately described as a finely ground glacial silt or till, so compressed in place as to be tight and impervious. Samples of this material, thoroughly dry, will disintegrate easily into an extremely fine granular material. It is the hard tough quality of this material which gave such difficulty in the piledriving operations.

The cofferdam site was first cleared of its overburden of boulders and basalt fragments by clamshell dredging. It was hoped that it would be practicable to remove in this trenching operation all rocks that would interfere with piledriving, but this hope was realized only in part.

Driving the piling

Preparatory work included hauling away boulders above water level and dredging with clamshell for the underwater trench. The latter was a slow tedious job requiring underwater drilling and shooting of many boulders whose sizes ranged up to 500 cu.yd. Excavation was carried on only where the sheetpiling was to be driven, and there a trench 12 ft. wide at the base was excavated through the overburden and into the till.

A breakwater crib extending some 250 ft. out into the stream was built just upstream from the cell cluster D. This afforded protection from the swift current during the driving. At first the driving was carried on from a trestle of timber piles on which electric whirleys handled the steel piling and the steam hammers. Guide frames for stringing the steel piling were of two types: (1) laminated wales made up of 1x6-in. pieces curved to fit the radius of the arc; and (2) steel I-beams curved to the proper radius.

Each cell was closed and the piling completely interlocked before driving. The piling was delivered in lengths of 80 and 40 ft., with a $\frac{3}{8}$-in. web and weighing 38.8 lb. per foot. To facilitate stringing and to avoid the use of extremely long booms, alternate half-lengths were used, and the webs were welded at the junction point after stringing. Threading was done by a man on a boatswain's seat—a particularly disagreeable assignment during one cold period of two weeks' duration in which the thermometer went as low as 20 deg. below zero.

Driving was done with steam hammers to which fishtail guides made up on the job were bolted at the sides and left extending about 5 ft. below it. This device greatly facilitated the work of the man in the boatswain's seat by aiding in placing the hammer quickly and holding it in a vertical position on the two piles always driven simultaneously.

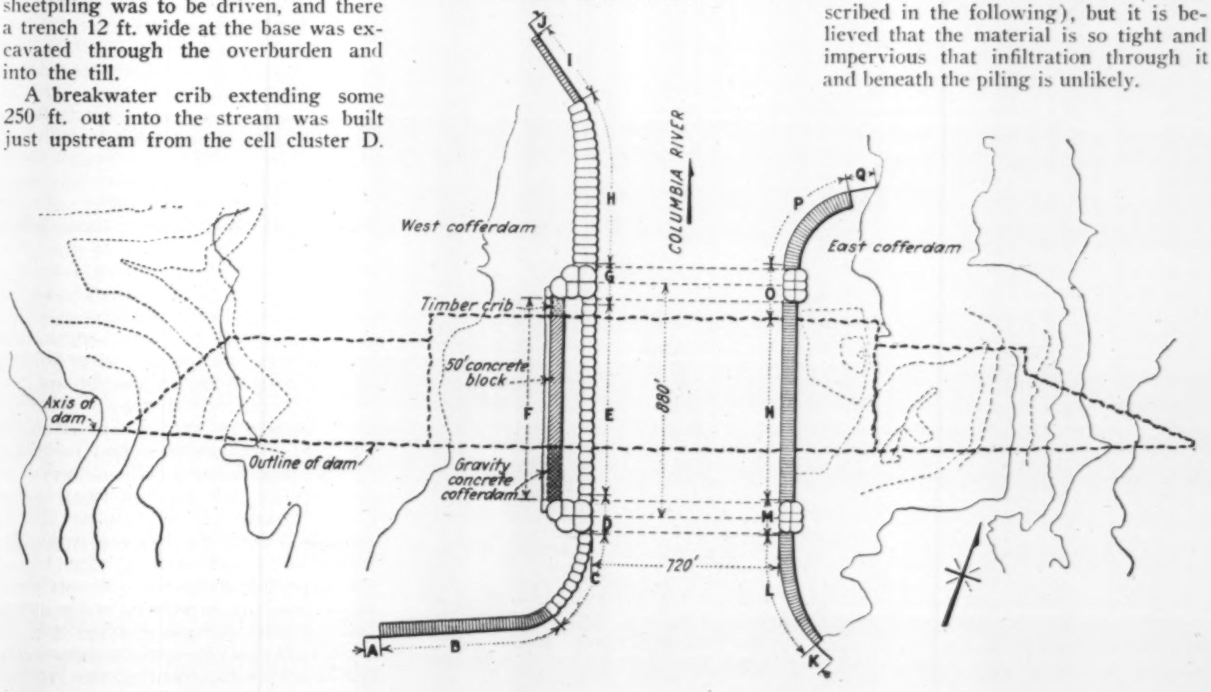
Four-hammer gantry rig

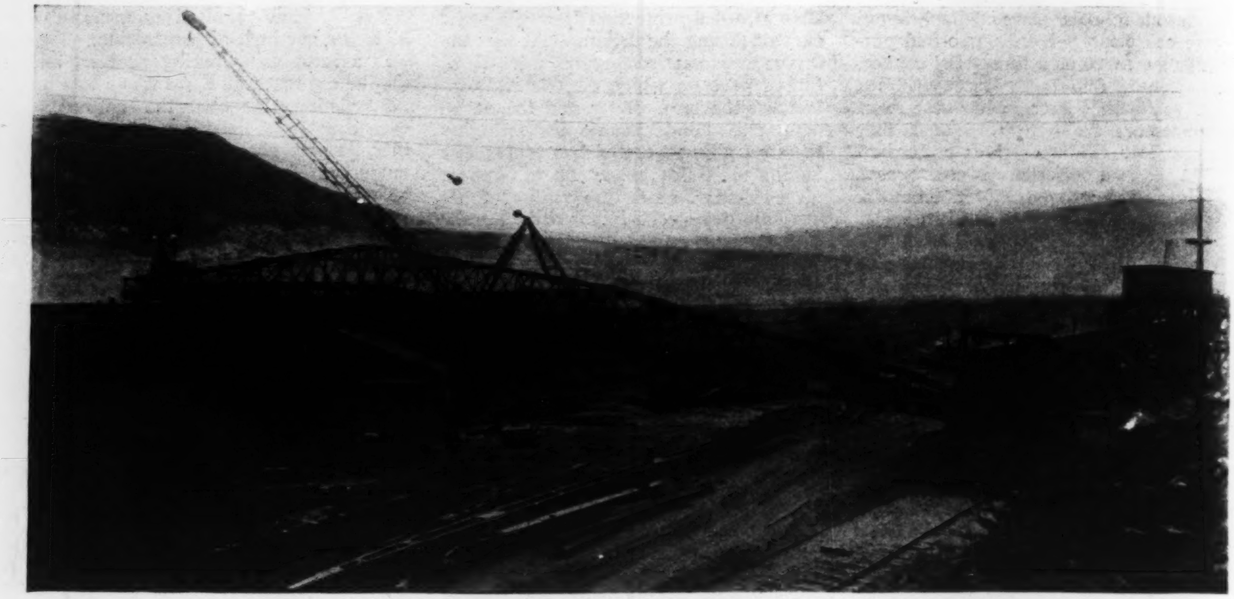
The hard till or young shale resisted the driving with remarkable stubbornness. As a rule, after the first 10 ft. of penetration, a hammer delivering a 13,000-ft.-lb. blow required an average of 35 blows per inch of penetration. This was a most discouraging process, and despite the fact that there was a total of *22* hoisting rigs over the cofferdam, each capable of handling a steam hammer, it was soon seen that the great amount of driving necessary could not be completed before high-water season unless the work could be speeded up.

Accordingly, a plan was devised for working four hammers on each cell instead of one. This was done by constructing a tower gantry of 70-ft. base width, spanning the cell structure and moving along as work progressed. On each side of the cofferdam this gantry was supported on a trestle. The steam hammers were carried on geared electric trolley hoists, each with a two-way motion so that the hammer could be spotted over any part of the cell beneath the gantry. Each hammer was suspended on a heavy coil spring, so that the shock of impact in driving would not be transmitted to the gantry. Altogether, 30 steam hammers were in service on the cofferdam (the largest single order for steam hammers that has been placed in recent years).

The tower gantry improved efficiency about 50 per cent and decreased the cost as compared to single hammers handled by long-boom hoisting rigs. Nevertheless it still was impracticable to accomplish the original objective of getting the sheetpiling along the river wall down to bedrock. The refusal point was reached after an average penetration of 40 ft. in the hard till. On this job refusal was set at fifty 13,100 ft.-lb. strokes per inch of penetration. This failure to drive the piles to bedrock somewhat changed the design of the river section of the cofferdam (as described in the following), but it is believed that the material is so tight and impervious that infiltration through it and beneath the piling is unlikely.

COFFERDAM LAYOUT for unwatering Grand Coulee Dam site.





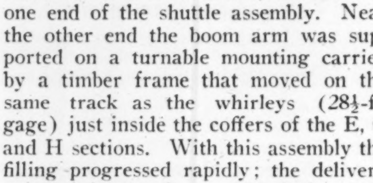
SHUTTLE CONVEYOR and boom arm inside the cofferdam with charging hopper at extreme right. This 870-ft. belt had a travel distance of 800 ft., which enabled it to fill the cells of the entire arm.

After the cells of the cofferdam had been completed, there yet remained to be placed some 400,000 cu.yd. of material: (1) inside the cellular coffers; (2) in the embankment behind the structure; and (3) in the toe fill. This first item, totaling about 275,000 cu.yd., was begun with motor trucks. The menace of the impending flood season, however, made it desirable to find a speedier method, and this was developed in the form of a group of three belt conveyors; these were called "shuttle conveyors" because the rig was shuttled back and forth as the fill progressed.

The material for filling in the coffers was brought from within the cofferdam area on a belt conveyor delivering to a hopper about midway of the E section and some 200 ft. back from the river face of the cofferdam. Under this hopper a track of 12-ft. gage was laid for a length of 1,600 ft. parallelling the cofferdam. The track was used by an 870-ft. traveling conveyor, which could move 800 ft. in either direction, and in any position could be fed by the hopper in the center of the track.

The shuttle belt was supported about 14 ft. above the track on timber bents, well braced to the framework, carrying the belt idlers and mounted on wheels so that each bent spanned the track. Originally the wheels were rigidly attached to the bottoms of the bents. Later, to reduce resistance and breakage of flanges, the footings were redesigned to use a pivot mounting with two 21-in. double-flanged wheels under each batter post. With this form of support there was play between bent and track, and the entire length of the shuttle was moved by a 10-hp. motor.

Operation of the shuttle belt was supplemented by a belt carried on a 200-ft. boom arm, which made delivery from the end of the shuttle to the location in the coffers where filling was in progress. The end of the boom arm at the shuttle was carried on a timber truck on the 12-ft. track, attached to one end of the shuttle assembly. Near the other end the boom arm was supported on a turnable mounting carried by a timber frame that moved on the same track as the whirleys (28½-ft. gage) just inside the coffers of the E, C and H sections. With this assembly the filling progressed rapidly; the delivery point of the shuttle was switched as convenience dictated until the operation was completed. Two 200-ft. boom arms were used, one at each end of the shuttle conveyor.



PILE HAMMER, with fishtail guides, drives 80-ft. sheetpiles two at a time for west cofferdam.

In filling with the shuttle conveyor, the lower portion of the fill was placed before the last lift of timber panels was put on the rear of the berm, thus avoiding lifting the filling material unnecessarily. To complete the fill to El. 990, the final timber panels were placed and an angle was put in the boom arm truss by bolting in an additional triangular section. This made the outboard end of the boom arm horizontal and facilitated swinging it to the desired position over the cells.

Pile-and-arch-set cofferdam

Two factors encountered during construction made it seem desirable to change the design of the river section (E) of the cofferdam. The first of these was that the many large boulders found in the riverbed made it desirable to move the face of the cofferdam westward toward the shore 150 ft. This considerably narrowed the width of the berm as originally planned. Later, when it was found impracticable to drive the sheetpiling entirely to bedrock along the river face, it was considered safer to modify the construction plan to provide a berm about 60 ft. wide between the inside of the coffers of the river section and the face of the excavation for the permanent concrete in the west cofferdam. To accomplish this, a construction was used along the F section involving vertical needle beams with a three-segment timber arch between them. The essential feature of this construction is that it will carry the pressure of the material behind and allow prestressing of the supporting members in the pit while preventing any movement of the material. It has been used previously in New York subway construction.

Along the line marking the location

of the needle beams a trench was first excavated to clay, and in the bottom of the trench 6-in. wash borings 10 ft. on centers were put down to bedrock. Because a layer of running sand was encountered about 20 ft. from the bottom, it was thought best to fill these 6-in. holes with a clay sludge or slurry to obviate the possibility that the sand would fill them after the well casings were pulled. The slurry was poured into the casings and remained in the holes when the casings were pulled. After removal of the casings a 21-in. I-beam was driven to bedrock in each hole.

The sectional area of the I-beam used corresponds roughly with that of a 6-in. circle, and it was believed that the equivalent area of soft material in the path of the driven I-beam simplified and speeded up the driving. With the I-beams in place, the timber arch between them was put in from the top down. That is, the first arch was placed at the top of the I-beams. Beneath this just the necessary excavation was made, segments of the second arch were put in and wedged tightly against the trench wall with hardwood wedges, and so on until the bottom was reached.

As the arches are placed, excavation along the line of the I-beams is carried on by means of a dragline, and, as the material is removed and the vertical I-beams are left unsupported, timber struts 80 ft. long are put in bracing these I-beams to the sheetpiles of the rear wall (section F). By this plan of construction the foundation rock on this portion of the site will be uncovered.

It is the plan to pour a portion of the concrete dam 50 ft. wide (measured along the dam axis) in the excavated area just described. This block of concrete will be carried up to El. 990, at least, and then is to be connected by cofferdam structures of two types to the cell clusters at D and G. This whole assembly—cell clusters, two types of cofferdam and the central concrete block—then will be the easterly channel limit when the river is diverted over the westerly portion of the dam.

The connection between the concrete block and cell cluster D will be a concrete gravity structure. Between the concrete block and cell G the connection will be a timber crib faced with splined sheeting on the water face. The crib type of construction was selected for this location because it will have to be removed below water level at a later date.

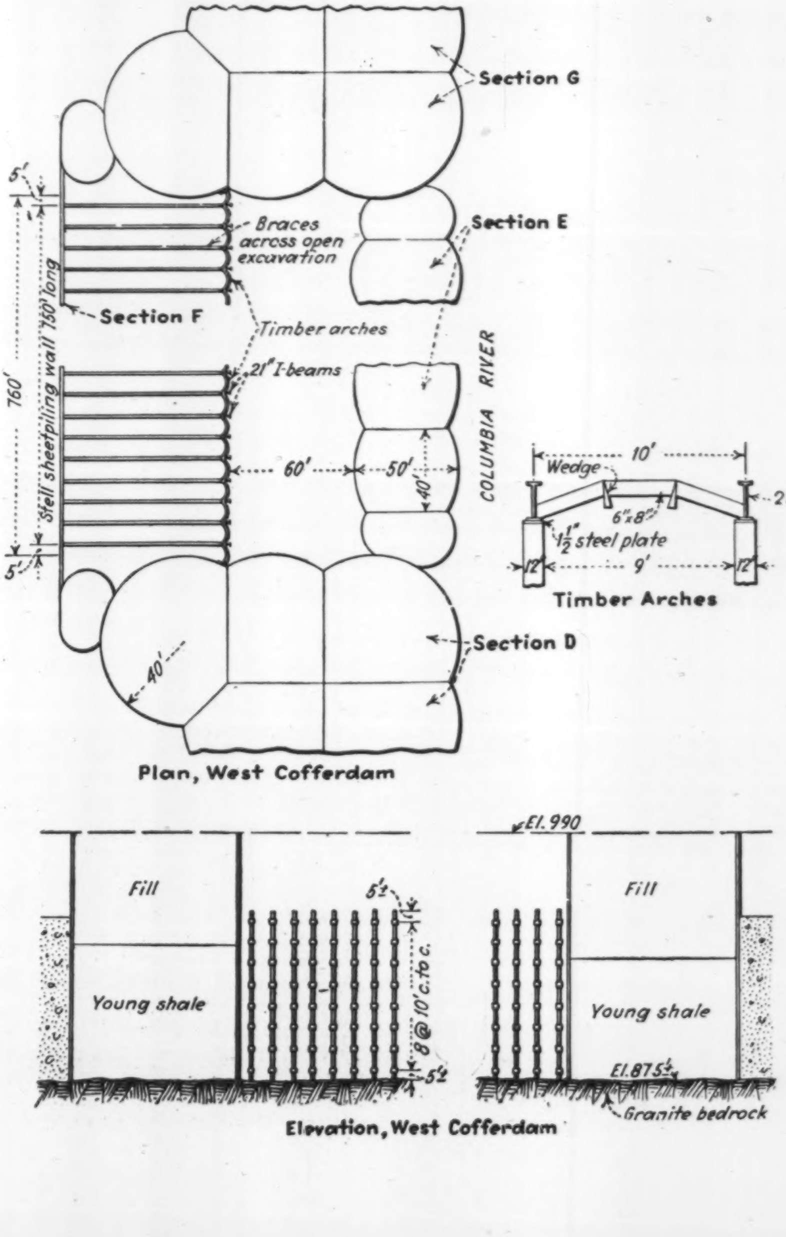
When these structures have been completed and the water head has been transferred to them, the embankment and the sheetpiling constituting section F can be removed, and the 50-ft. concrete block can be connected with concrete foundations previously poured within the protection of the west cofferdam. This plan leaves a concrete face projecting into what will finally be the central or river cofferdam. Thus the final closure can be made here when the river portion of the foundation is unwatered.

Thus far, the cofferdam construction has been found to be eminently satisfactory. Up to June 15 the maximum streamflow in the Columbia had been 344,000 sec.-ft., and the maximum water level was at El. 972, which is 32 ft. above normal low water. This water level did not cause any material amount of seepage into the west cofferdam area. In fact, the infiltration into the drainage wells within the cofferdam has been from the land side rather than from the river. Eight 4x8-ft. drainage pits have been excavated to bedrock 170 ft. back from the river face of the cofferdam. None of these showed a heavy water flow, and one was entirely dry.

Whether it will be necessary to allow the west cofferdam to flood during the period of highest water in the Columbia depends upon the height of the peak flow this season. While the natural flood channel is somewhat restricted by the west cofferdam, it is estimated that the flood can reach 550,000 sec.-ft. without overtopping the cofferdam (El. 990). However, should prospect of overtopping develop, equipment can be removed from the area within the cofferdam, and probably the only delay would be the duration of the peak flow plus the time required to pump out and dry the cofferdam after the river subsided.

Evolution of the belt-conveyor method of wasting excavated material that has reached its most extended development at Grand Coulee Dam is described by the contractor's engineer in the following article.

DETAIL OF NEEDLE-BEAM SECTION of west cofferdam wall, where connection will finally be made to last coffer, enclosing main channel.



BELT CONVEYORS FOR SPOIL TRANSPORT

Three articles on the planning, design and use of a mile-long series of belts that is moving spoil out of the hole and over the hill at Grand Coulee

I—Planning for Excavation Disposal

Great belt-conveyor system at Grand Coulee that is moving over 10,000,000 cu.yd. of excavation from the dam site is a development by the contractor from experience on the Boston vehicular tunnel and the diversion tunnels at Fort Peck Dam

By Francis Donaldson
Chief Engineer, Mason-Walsh-Atkinson-Kier Co., Contractors, Grand Coulee Dam, Mason City, Wash.

WELL-LOADED BELT approaching from a charging pit on its way to deliver a ton of spoil per second over the mile-long conveyor system.

THE belt-conveyor system for handling spoil at Grand Coulee Dam is not an application of this device to a new purpose. Excavated material was long ago transported on belts, but beginning in 1931 on tunnel work an extension of the method to far greater distances of haul and by unique special devices has been accomplished. This recent development is, because of its success, of commanding construction interest.

Boston Traffic Tunnel

The Boston Traffic Tunnel, a shield-driven, vehicular tunnel, was constructed by the Silas Mason Co., in 1931 and 1932, and the 31-ft. shield was provided with a short conveyor originally designed to transfer muck from the shield pockets to tunnel cars. Shortly before excavation was begun, it occurred to H. L. Myer, manager of the contract and now general manager at Grand Coulee Dam, that if the muck would travel on a conveyor from the shield to a car, there was no good reason why it could not continue so to travel if the conveyor were extended. The objection at once arose that the tunnel was to be driven under compressed air, and hence the conveyor would have to pass through an air lock. In order to surmount this difficulty, a double-barreled conveyor lock was developed by the company's mechanical engineer, L. F. Parker, assisted by Stanley M. Mercier of the Jeffrey Manufacturing Co. The lock and the conveyors inside and outside of air pressure were constructed and installed, and the scheme proved to be a great success. All of this was written up in detail in *Engineering News-Record* of June 30, 1932, and is now ancient history, but it serves to illustrate the development of an idea.

Fort Peck Dam

In April, 1934, Silas Mason Co., in partnership with the Walsh Construction Co., secured the contract for the diversion tunnels for the Fort Peck Dam. The same management being in charge, the belt-conveyor idea cropped up again. Here, however, conditions were different; in Boston the tunnel was straight and the muck had to be delivered to trucks at the shaft head. At Fort Peck the tunnels were curved and the muck had to be delivered to an elevated dump some distance from the tunnel portals. The Boston scheme was, therefore, reversed and, instead of carrying muck out of the tunnel on a belt, cars were used to deliver the muck to a feeder, and a belt conveyor was employed to transport it from there to the dump. This method obviated the delays that would have been caused on either a railroad or truck dump by the slippery ground and severe weather conditions that often occur at Fort Peck.

The transfer of the material from belt to dump required the development of a suitable movable "stacker." Since the tunnels were to be driven from both ends, two belt systems and two stackers were required. The 30-in. system at one end was designed and furnished by the Jeffrey Manufacturing Co., and the 36-in. system at the other end by Barber Greene Co.

Grand Coulee Dam

The writer first saw the site of the Grand Coulee Dam shortly before the bids were opened in June, 1934. The contract quantity of material in the west side excavation was some 6,000,000 yd., and, due to the cliffs which form the left bank of the Columbia, no low-level dump was available within several miles. The cost of constructing and operating either a railroad or a truck road to such a dump was, therefore, prohibitive. Rattlesnake Canyon, however, provided an excellent dump for many million yards of spoil within a mile or so of the excavation, but the floor of the canyon was 150 ft. above the river, and the rim of the canyon was most inaccessible from the pit due not only to a difference in elevation of some 400 ft. but also to the aforementioned cliffs. At once there came into the writer's mind the experience of the Mason Co.'s organization in transporting, in Boston, soft clay to a distance of a mile and, at Fort Peck, broken shale up a steep hill to a dump fed by a movable stacker. A belt conveyor seemed to him to be the answer to the disposal problem.

Mason - Walsh - Atkinson - Kier was successful in obtaining the contract, and the details of the conveyor installation were worked out by the same group of men who had built the conveyors on the other two jobs, again with the assistance of the Jeffrey Manufacturing Co., who furnished the equipment at Grand Coulee. These details and a description of the conveyor as a whole are fully set forth in following articles. Suffice it here to say that the hourly output has been satisfactory, the percentage of lost time small and, in short, the entire system successful.

Experience with disposal conveyors on these jobs serves further to emphasize a fact already well known—namely, that a belt will transport satisfactorily different kinds of material if proper means are provided for loading and unloading the belt. In Boston the clay, sometimes soft and plastic, was excavated manually in the shield, and the pieces as broken or cut out were loaded through chutes on slow-moving pan conveyors that fed the belt. These conveyors overhung the main belt sufficiently to permit the belt to be extended as required in 22½-ft. sections, and the belt supports were arranged so that these sections could be quickly installed. At the discharge end the belt fed an inclined scraper conveyor which, in turn, loaded either of three large, short, slow-moving pan conveyors, manually controlled, and provided with high sides. These conveyors served as bins with movable bottoms, and were utilized for loading the trucks.

The Fort Peck material was Bearpaw shale, and in the tunnels it was drilled, blasted and loaded by mechanical muckers. The pan conveyors used in Boston as bins for loading the trucks were converted at Fort Peck into belt feeders, one for each main belt, and received blasted muck from the tunnel cars. Since the fragments were too large to travel on the belt satisfactorily, a high-speed, high-capacity rotary crusher, through which the entire discharge of the feeder passed, was placed between each feeder and its belt. The feeders were automatically driven at a speed that loaded the belts to capacity. At the discharge ends the stackers were provided with swinging booms to distribute the streams of material over wide areas and with traction gears and motors to permit forward motion under their own power; they were designed with telescopic tails, which enabled the main belts to be extended behind them in sections, quite like the extension of the Boston belt behind the shield.

At Grand Coulee the same type of feeders was adopted as at Fort Peck, but they were enlarged and provided with greater power. Here the material varies from sand and gravel to a fine shale-like substance, and at times contains a large number of hard boulders. Since crushers of sufficient capacity were impracticable, the feeders were arranged to discharge directly on the belts, and above the feeders grizzlies were placed, through which all material is dumped. Boulders too large to be carried by the belts are thus screened out and handled separately by trucks. The simplest form of grizzly proved to be a horizontal type with bars strong enough to support the weight of heavy crawler tractors provided with bulldozers. After a sufficient number of boulders have accumulated to block the grizzly openings, these boulders are bulldozed to one side and afterwards loaded into trucks by a small shovel. At the same time, fragments of the shale that are too large to fall through the openings are pushed through by the tractor treads, the tractors thus serving both as cleaners for the grizzlies and as crushers. On the discharge end of the belt the Fort Peck type of stacker is used, but, owing to the much greater weight of belt and material, a swinging boom was impracticable. An independent boom supported by powered crawler treads, arranged to travel in a circular arc, performs the same function. No essential change was made in the telescopic tail.

The following article describes specifically the mile-long belt conveyor that is moving 10,000,000 yd. of spoil from the west cofferdam to a waste pile in an adjacent canyon.

II—The Belt Conveyors in Operation

Series of belts, requiring 5,000 hp. to operate, is lifting millions of yards of excavated material more than 600 ft. and carrying it a mile to a dump in a canyon above the dam

IN PREPARING the Grand Coulee Dam site for concrete, the major undertaking is excavating the material that overlies bedrock and transporting it to a spoil bank where it will not be in the way of later operations and functions. The total quantity of material to be moved is not yet exactly known. The present M.W.A.K. contract was made on the estimated figure of 11,000,000 cu.yd.; more recent developments indicate that this total may be increased before the contract is finished to more than 15,000,000, in addition to which earlier contracts and work yet to be done on slides, etc., probably will boost the grand total for the project to more than 17,000,000 cu.yd.

Attention is concentrated at present on exposing the bedrock in the area at the west end of the dam from which the river was shut out by the 3,000 ft. of cofferdam completed early this year. About 10,000,000 cu.yd. probably will be excavated from the west cofferdam area and moved to a spoil bank in Rattlesnake Canyon, a ravine on the west bank of the river just above the dam. For transporting this material a 5-ft. belt-conveyor system has been installed, designed for a capacity of 2,500 cu.yd. per hour. Including the four feeder units, this system is now 6,048 ft. long, and the gross lift is 543 ft.; both these figures will increase as the job progresses.

The prominent features of the belt-conveyor system are the arrangement of feeder units to obtain uniform loading, interlocking controls to prevent piling up of material along the line when trouble develops, and a grouping of equipment at the discharge end of the line which gives great flexibility without interrupting operation. Although the greater part of the work of moving material from pit to dump is done by belt conveyor, yet every yard of material that moves out on the belt is first excavated by power shovel and hauled to the belt feeders in motor trucks or tractor-drawn trailers; bulldozers play an important part in the opertaion.

As in many other operations of this project, installation of the belt conveyor was decidedly a rush job; the entire conveyor system was designed, delivered, installed and assembled in working order within three months. It was put in operation for the first time on Dec. 13, 1934.

Operation of feeders

The main conveyor system starts at a hub centrally located in the cofferdam area, and the plan is to have several feeder belts continually supplying this hub; these auxiliary belt lines will be moved about as excavation proceeds. The intent is to keep about four feeder belts tributary to the hub, with one of the four always in process of relocation. Two feeders working at capacity could supply a full load for the main belt; it is expected that the other feeders will insure constant flow of material while time out for repairs is required on any one unit.

The scene in the cofferdam is one of ceaseless activity. Dump trucks and tractor-hauled wagons with capacities varying from 12 to 20 cu.yd. deliver their loads to a grillage of steel I-beams having 13-in. openings. Boulders that

TYPICAL DELIVERY from 12-cu.yd. wagon to grizzly; bulldozers follow wagon over the grizzly, scraping boulders aside for later removal by truck.

will not pass through the grillage are scraped off by the bulldozers, which continually clean up as dumping proceeds. The grizzly bars are of heavy, built-up hollow sections with a slight taper downward. The badly battered condition of many of these bars bears testimony to the heavy duty that they perform and the amount of wear that they save the belts.

Beneath the grizzly the material falls onto the hopper of a feeder, which is a 65-ton assembly of structural steel and the framework of an apron conveyor. Its function is to equalize the irregularity of truck deliveries and to make the loading on the belts as uniform as possible.

Above and along the sides of the movable apron of the feeder is a combination skirt and hopper that holds about 40 cu.yd. The skirt or side walls diverge toward the discharge end, where their separation is greater by 12 in. than at the other end of the 30-ft. feeder belt. This flare tends to relieve the pressure between the side walls as the material moves out.

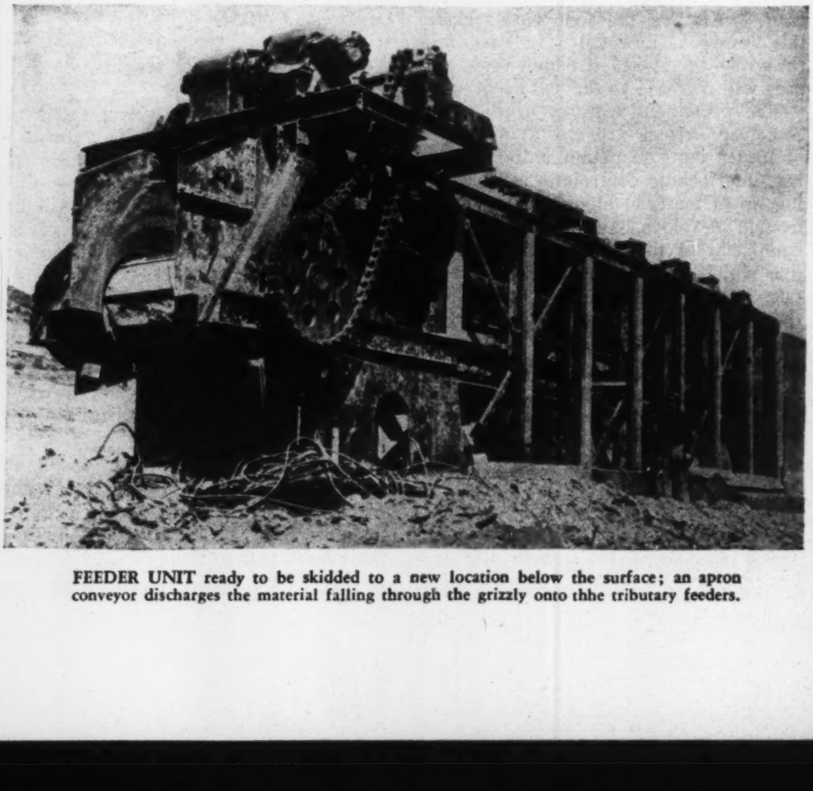
These feeder units are planked on their under sides and have steel shoe plates resembling skids, to facilitate moving. Ordinarily they are placed in pits to lessen the grade up which material has to be hauled to dump into their hoppers. A feeder unit ordinarily is maneuvered into a new pit location by three tractors; one pulls, one works as a bulldozer to aid in slewing, and one follows on a snubbing line to ease the feeder down into the pit.

The most important control point on the belt-conveyor system is in the hub where the several feeder belts deliver to the main belt line. The length of truck haul from shovels to feeder units ranges up to 500 ft. or more. During the short hauls two feeder belts are sufficient to supply the main conveyor belt. Where the hauls become longer, three feeder belts are used. The operator at the hub controls a surge feeder over the main belt. Its function is to load the main belt uniformly and at capacity. The operator's control over this function is by stopping any or all of the feeder belts when an overload begins to pile up in the surge feeder. The feeder-belt units now in use are about 350 ft. long, but as the excavation progresses downward it is expected that two or more successive units in line will be required to lift material from the lower parts to the hub.

Beyond the hub feeder the dirt is moved by the main conveyor. It has a belt 60 in. wide moving at a speed of 620 ft. per min. and is made up of nineteen separate units from the hub to the spoil bank in Rattlesnake Canyon. At present the length of the main belt line is 4,648 ft. and the aggregate length of feeder belts is 1,400 ft., bringing the total to 6,048 ft. The length of the main line will be increased as the fill at the dump advances, probably to an ultimate total of more than 1½ miles. The main belt was designed to be able to transport 2,500 cu.yd. per hour, or 52,500 cu.yd. per 21-hour day; it is expected that with well-regulated operation the capacity will considerably exceed this figure. Thus far the maximum day's work has been 50,700 cu.yd.

Each of the nineteen belt units is powered with a 200-hp. electric motor equipped with reduction gears and a V-belt drive. The lengths of the conveyor units vary with the grade; the shortest is 156 ft. and has a 14-deg. slope, and the longest is 415 ft. Each unit drops the material 6 to 8 ft. in making the transfer from one belt to the next. The 8-ft. loss occurs at angle points, where more headroom is required; the 6-ft. drop is sufficient for a straight-along transfer point. These transfers are not made with a chute; the discharge from one belt is directly onto the belt below. To aid in carrying the impact which this involves, larger rubber-covered idlers are used for a length of about 8 ft. where the belt receives its load.

While overburden was being removed from the cofferdam area and rocks were frequent in the material, a piece of old railroad rail was used as a "splitter," being mounted over the belt just above its receiving area, to take the impact of falling rock. When the excavation



FEEDER UNIT ready to be skidded to a new location below the surface; an apron conveyor discharges the material falling through the grizzly onto thhe tributary feeders.

got down to a level where rock is less frequent and the material is more inclined to be sticky, a tendency for the material to pile up on the splitters made it desirable to remove them. On June 15 the lowest feeder grizzly was at El. 889 and the surface of the spoil bank at El. 1355, a net lift of 466 ft. To obtain the gross lift, there should be added a loss of 160 ft. representing the drops at the grizzlys and at the successive transfer points, or a total lift of 626 ft. The lift above (horizontal transportation and friction excluded) calls for about 2,500 hp. when the belt is handling 4,000 tons per hour, as this load requires 4 hp. per foot of lift.

At the upper end of each unit a house encloses the driving mechanism of the unit; each of these points is a control station from which the operation of the belt motors may be stopped. The control for each motor is interlocked, so that starting and stopping is in a predetermined sequence. When the stop button is pushed at any point, the preceding conveyors only are affected; the succeeding conveyors continue on with their load. Similarly, when starting from any point the feeding conveyors only are started, and buttons on each successive unit must be pushed to bring the entire belt system into operation.

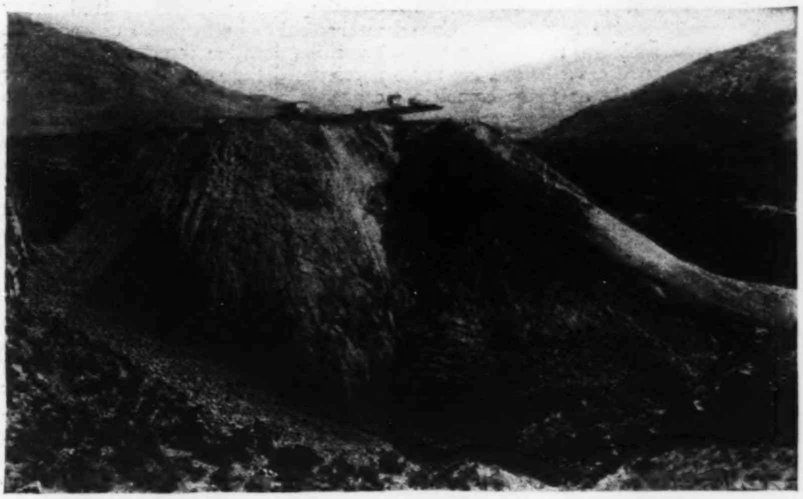
A walkway paralleling the belt connects the headhouses, in each of which there is a telephone. In normal operation one man is sufficient for every four or five headhouses. All driving parts are interchangeable and are mounted on self-contained steel frames. Counterweighted gravity take-ups are used. Idler spacing under the loaded belt normally is 42 in., and under the return belt 7 ft. The main conveyor line has been roofed over to shelter workmen and belt from sun and rain.

The main conveyor belt is about $\frac{3}{4}$ in. thick and consists of eight-ply fabric with a $\frac{5}{32}$-in. rubber cover. The fabric is a 32-oz. duck in the main belt, while in the telescope units at the discharge end a 42-oz. duck is used. When conveying earth and soft material the belt shows very little wear, but large rocks or large percentages of rock wear and sometimes tear the fabric. Repairs are effected by releasing the tension on the belt and lacing in new belting to replace a damaged portion.

Operations at the spoil bank

At the delivery end of the main belt line an arrangement has been developed which permits uninterrupted delivery as the discharge end is moved along the face of the dump or extended outward as the fill advances. This is accomplished by three units: an extensible conveyor, a telescoping conveyor and a cantilever boom conveyor or stacker. The extensible conveyor, which takes delivery from the last of the standard units on the main line, readily can be extended in length 49 ft. at a time until it reaches a total length of about 300 ft., at which time a complete new drive unit is substituted and the extensible conveyor is retracted and moved ahead.

The extensible conveyor delivers to a telescoping unit which has a 49-ft. movement. This unit makes such gradual advance as is required up to the 49-ft. limit (when a new unit is added to the extensible conveyor) and delivers to the 175-ft. boom conveyor. The original boom length was 150 ft. but, as this brought the tractor so close to the edge that it was endangered by slides, a longer boom was substituted. The boom conveyor is supported at its loading end on a turntable, and its midpoint is carried on a tractor. The tractor can move the boom gradually back and forth through a 180-deg. arc so that its discharge end swings along the face of the dump, while movement of the telescope section can advance it gradually 49 ft. A short stop then is necessary to increase the length of the extensible section. A universal mounting over the tractor enables it to be turned to any angle with the conveyor axis.



DISCHARGE END of the long belt. Material stands first on 1:1 slope but slips down to 1:5 slope. Master control tower is seen on boom above belt.

With this arrangement the stacker belt can be swung and advanced without interrupting delivery. Both radial and forward speeds are 10 ft. per minute, controlled from the operator's station on the boom above the tractor. At this point is located a master control for the main conveyor system as a whole.

ELECTRIC MOTORS ON BELT-CONVEYORS

	Hp.
Cofferdam	
Four feeder units @ 60	240
Four feeder conveyors @ 200	800
Hub feeder unit	75
Main conveyor belt	
Nineteen conveyor units @ 200	3,800
Spoil bank	
Telescope conveyor unit	150
Stacker belt (boom)	100
Boom chassis	10
Tractor on boom	20
Total	5,195

The angle of repose of material on the dump remains at 45 deg. for only a very short time. The dump slowly but continually slides forward in front of the discharge point of the stacker and takes a very flat angle. In fact, the material does not seem to come to rest; the toe of the dump is continually moving up the canyon, away from the stacker belt, at the rate of about 5 ft. per day. At present the dump under the boom is 230 ft. deep, and the toe of the slope, to which continuous movement extends, is 1,020 ft. ahead—an average angle of 1 on 5.

This extremely flat slope was unexpected and has attracted much attention. Late in July the stacker had been in the same location for eight weeks; the material continuously had broken at the shear line under the boom end. The added load, as material continues discharging over the boom, seems to cause this extreme forward movement.

Slides in the face of the dump endanger the equipment assembled on the fill. To increase the capacity in the fill area the surface of the dump is maintained on an upgrade of 7½ per cent. The surface is smoothed up by a bulldozer supplied with additional material, when needed, by a plow slung above the stacker belt. The plow is dropped down so as to crowd material off the belt at a point where it can be reached conveniently by the bulldozer.

The belt conveyor was designed and built by the Jeffrey Manufacturing Co., for whom Stanley M. Mercier, assisted by R. M. Matthews, supervised the installation and has directed the service rendered on the job.

The special engineering problems of belt-conveyor planning and detail design for the heavy duty of spoil-conveying at Grand Coulee Dam are outlined in the following article by the manufacturer's equipment engineer.

III—Designing the Belt System

Besides being custom-built for the conditions at Grand Coulee, the design had to consider overload, safety, extensibility and mobility of pick-up and discharge of load

By Stanley M. Mercier
Engineer, The Jeffrey Manufacturing Co., Columbus, Ohio

IN USING conveyors for the major transportation and disposal of excavated dirt at Grand Coulee, the contractors have shown that the pioneering spirit of the West is still a vital American characteristic. Conveyors have replaced trucks for this purpose in isolated cases before, but not on so large a scale or to so complete an extent. The contracting world now definitely has a new and reliable tool available, which Grand Coulee proves is economical, reliable and admirably adapted to high-speed operation in difficult situations. The experience of the contractor's organization and particularly of H. L. Myer, the job manager, has played an important part in this development.

General requirements that determined details of design

To be successful in this field, conveying systems must be flexible and readily mobile in the pit and on the dump, and many little wrinkles have to be worked out to achieve this result economically. Further, it is essential that the design be more rugged and liberally proportioned than usual for conveyors in industrial practice. Among other things, special safety precautions must be observed, to fit this machinery to the use and supervision of help in some cases not altogether skilled.

Another essential requirement of success is that this equipment, which of course is custom-built, be developed, designed and detailed on the job rather than in some manufacturer's office. This provides the necessary speed in preliminary studies, enables correlation of the conveyor functions with those of other equipment, and permits quick and easy changes of detail when needed; it also affords the opportunity of incorporating in the system the best ideas of all field operating heads concerned with the project.

The accompanying drawings show simply the plan of the conveyor system installed and indicate approximately the successive positions of tributary feeders and conveyor lines within the excavation. This plan of course involved truck-traffic and shovel-progress studies in conjunction with topographical consideration, to determine the best place for starting. Surveys of the hillside were run and compared, to decide the best location of a conveyor line up the side of the Columbia gorge to the dump.

As the stacker itself involved many mechanical detail problems and its launching location interfered with and necessitated the removal of an existing camp, it was considered desirable to provide a temporary dump for the first few weeks' operation. Electrical problems were quite extensive. They involved transformer stations, the selection of controls adequately to provide for automatic sequence starting, to avoid excessive peak loads in starting, and ample emergency stop buttons for safety provision. When it is considered that this enormous installation was conceived, engineered, manufactured and installed in 2½ months, the contractor deserves congratulations for his close coordination with the manufacturer, which must necessarily have existed.

For speed and simplicity of design it was decided that all main-line belt-conveyor terminals should be alike, and that the combined demands of length and slope of each conveyor should absorb the same electrical horsepower where the contour of hillside would permit.

For economy of horsepower it was decided to attempt the transfer of material between conveyors without the use of typical transfer chutes, whose functions were served instead by adjustable deflector plates and baffles, the character of these being varied according to the relative slope and angle of the conveyors involved.

This very novel treatment of the transfer problem involved much study and was experimentally modified by the operating forces until each transfer was satisfactory. As the character of excavated material changed, these transfer features were modified to suit. Heavy-duty idlers were used under the belt at these points, and when the shock of larger pieces indicated it to be desirable, these idlers were rubber-covered and fitted with maximum-size shafts and bearings.

Excavation-pit equipment

The tributary feeders in the pit are of the apron conveyor type, rugged in construction, to withstand the heavy sustained load. The chains have an ultimate strength of 200 tons and are equipped with large-diameter cast-steel rollers. These feeders are supported in large steel frames that are wood-sheeted outside. Ample space is provided inside for supervision and repairs as well as for cleaning up any dirt that may dribble through. Certain other features of the feeder design are indicated in the drawings and other illustrations of these articles.

Feeders reset as excavation in pit goes deeper

In installation, a trench is excavated to sufficient depth, and the associated feeder is dragged to place and buried. Then the ground is levelled for truck traffic. Each set-up of the feeder is sufficient for three or four or more weeks' operation according to conditions; when general excavation has proceeded far enough, the feeder and conveyor are reset at a lower level. Although two are entirely sufficient for capacity, four tributary feeders are used so as to provide for resetting without interrupting steady full-capacity operation.

At the hub or point of convergence of the tributary belts a surge hopper and feeder are introduced to feed the main line and protect it against those momentary overloads that might occur with some character of materials when more than two feeders are in use at the same time.

Spoil-dump equipment

The stacker is, of course, the crowning glory of the line. Without this unit, which permits the uniform and continuous disposal of material on the dump, the system would be incomplete, and its disposal rate would be greatly devaluated. A line diagram of this stacker is shown in the drawings. It will be seen to consist really of three units as follows:

1. An extensible conveyor that is added to in 50-ft. belt sections as the dump progresses and whose head end is supported on a 50-ft.-long, four-wheel truck, straddling the second unit.
2. A telescopic unit whose foot end is located under the head or discharge end of the first unit and arranged to travel freely through a distance of 50 ft., receiving its load from the first unit at any point in this range. The head end of the unit is elevated to permit discharge to the third unit.
3. A conveyor boom supported at its pivot point so as to receive the dis-

charge from the second unit and supported on crawler treads at an intermediate point so as to facilitate moving through an angle of 180 deg. on a 175-ft. radius.

This conveyor has full provision for movement in a vertical plane at its pivot point, to conform to the rough ground conditions on the dump and, by means of a leveling table, to keep the boom conveyor laterally level at all times.

The crawler support at the intermediate point of the boom is located sufficiently far back from the boom tip to guard as much as possible against slips in the dump without introducing undesirable heavy soil pressure under the treads. This crawler mounting also has full provision for movements to conform to irregular dump surface without introducing any twisting or binding stresses due to irregular surface or to the failure of the treads to track in a true circle around the pivot center.

Both the crawler mounting just spoken of and the chassis supporting the pivot of the boom and the head end of the telescopic unit are propelled by individual electric motor drives under the control of an operator in the small cab shown on the stacker boom immediately over the crawler support. Soil pressures exerted by all parts of the stacker assembly are confined to 6 or 7 lb. per sq.in., to avoid difficulty due to the soft surface of new dump; and rail pressures are confined to safe limits in conformance with conservative practice so that local settling or bending of rails will not be a problem to the engineers.

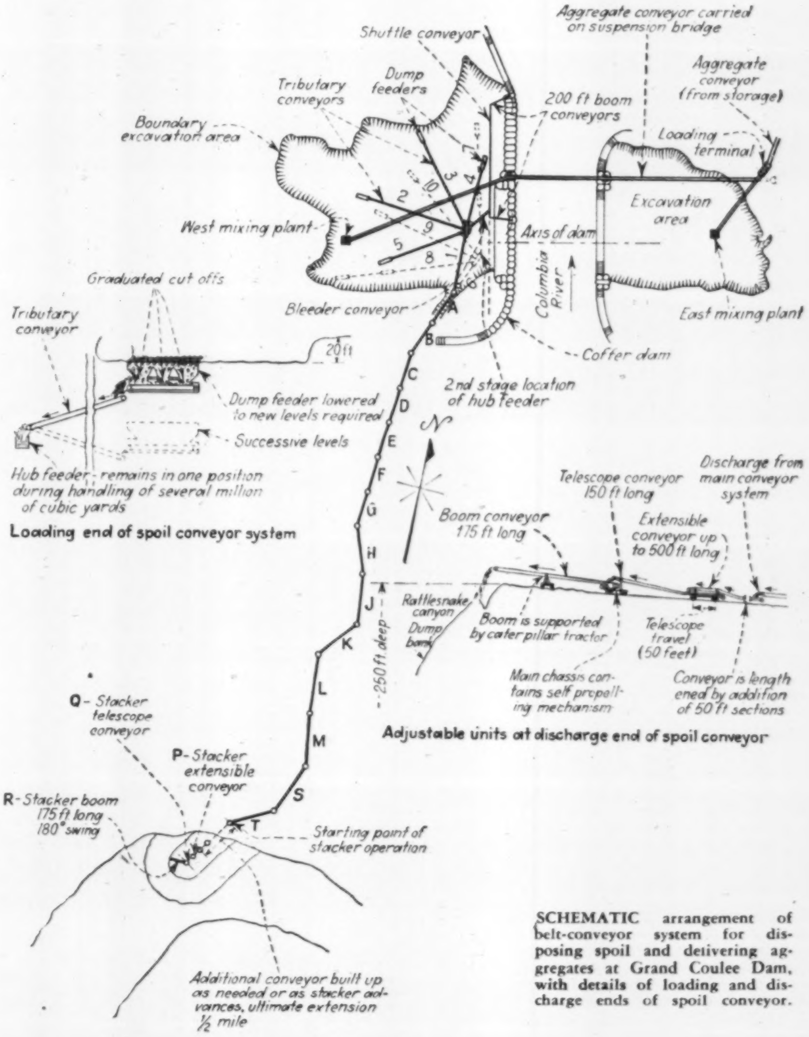
To pivot the stacker boom or propel forward the stacker boom and telescopic conveyor, it is not necessary to stop production until a forward movement of 50 ft. has been accomplished. Then the stoppage of the system for the purpose of inserting a 50-ft. section in the extensible conveyor does not exceed half an hour and is always so scheduled as to take place during one of the three hourly rest periods, which are scheduled anyway in every 24 hours.

The detail provisions incident to extending the extensible conveyor in so short a time are well thought out, and a trained crew of men is expertly directed to accomplish this remarkably quick performance.

Performance records

The capacity of the system was fixed at 4,000 tons per hour, which is approximately 2,500 bank-yards per hour, but this would vary considerably according to the amount of swell experienced in digging.

The best seven-hour shift performance is 17,478 bank-yards, and the best daily 21-hour output is 50,700 bank-yards. Usual daily performance somewhat exceeds 40,000 bank-yards for three shifts. So far, the maximum operating period without shutdown due to conveyor trouble of any sort is 59 hours, 8 min. Usually shutdowns are for the purpose of removing occasional undesirable large boulders that manage to get though the grizzly over the dump feeder, and actual shutdown will be from 1 to 10 min. depending on where along the line the large piece is first noticed. The average total of such shutdown periods is about one hour in 21, or less than 5 per cent of total time. Occasionally one of these large boulders is not detected in time and damages a belt. Such damage sometimes may be sufficiently serious to necessitate prompt shutdown for repairs, which may take an hour or more.


Shuttle conveyor
Aggregate conveyor carried on suspension bridge
Tributary conveyors
Dump feeders
200 ft boom conveyors
Aggregate conveyor (from storage)
Boundary excavation area
Loading terminal
Excavation area
West mixing plant
Axis of dam
1
2
3
4
5
6
7
8
9
10
Columbia River
Graduated cut offs
Bleeder conveyor
East mixing plant
Tributary conveyor
20 ft
A
B
Cofter dam
C
2nd stage location of hub feeder
D
Dump feeder lowered to new levels required
E
Successive levels
N
F
Hub feeder - remains in one position during handling of several million of cubic yards
G
Loading end of spoil conveyor system
H
J
K
L
M
S
T
Telescope conveyor 150 ft long
Discharge from main conveyor system
Boom conveyor 175 ft long
Extensible conveyor up to 500 ft long
Rattlesnake canyon
Dump bank
Boom is supported by caterpillar tractor
Telescope travel (50 feet)
250 ft. deep
Main chassis contains self propelling mechanism
Conveyor is lengthened by addition of 50 ft sections
Adjustable units at discharge end of spoil conveyor
Q - Stacker telescope conveyor
P - Stacker extensible conveyor
R - Stacker boom 175 ft long 180° swing
Starting point of stacker operation
Additional conveyor built up as needed or as stacker advances, ultimate extension ½ mile

SCHEMATIC arrangement of belt-conveyor system for disposing spoil and delivering aggregates at Grand Coulee Dam, with details of loading and discharge ends of spoil conveyor.

Controls

The electrical system is divided by banks of stepdown transformers to each group of three conveyors. Controls provide for automatic sequence starting of the line from the stacker boom back to the tributary belts. Feeders are separately and manually started but so interlocked that they cannot be started unless the belt line is in full operation. The stopping of any unit in the system by operating stop buttons, which are plentifully provided, or by any sort of electrical failure, results in stopping all units behind the one so stopped, but does not interfere with those going on to the dump. From a safety standpoint the entire line is well lighted for its entire length, and moving parts are guarded as much as possible. In addition, safety instructions are posted around the line in conspicuous places, and severe disciplining is meted out for non-observance of instructions. The safety record of the conveyor line appears to compare very favorably with the other operating departments.

In preparation for placing dam concrete this fall, one of the most complete plants for sorting, cleaning, stockpiling and delivering aggregates for concrete has been installed, as described in the concluding article, which follows.

Making Aggregate at Grand Coulee

From pits 1½ miles away aggregate will be sorted into four coarse sizes, three sizes of sand will be blended, and all will be washed and stored to be delivered by belt conveyor to separate bins and thence by belt conveyors to two mixing plants

IN PLANNING the aggregate plant for Grand Coulee Dam the quantity of material required put a high premium on keeping handling costs to a minimum. Under the low-dam contract some 3,500,000 cu.yd. of concrete is needed, and the high dam will increase this figure to 10,000,000 cu.yd.

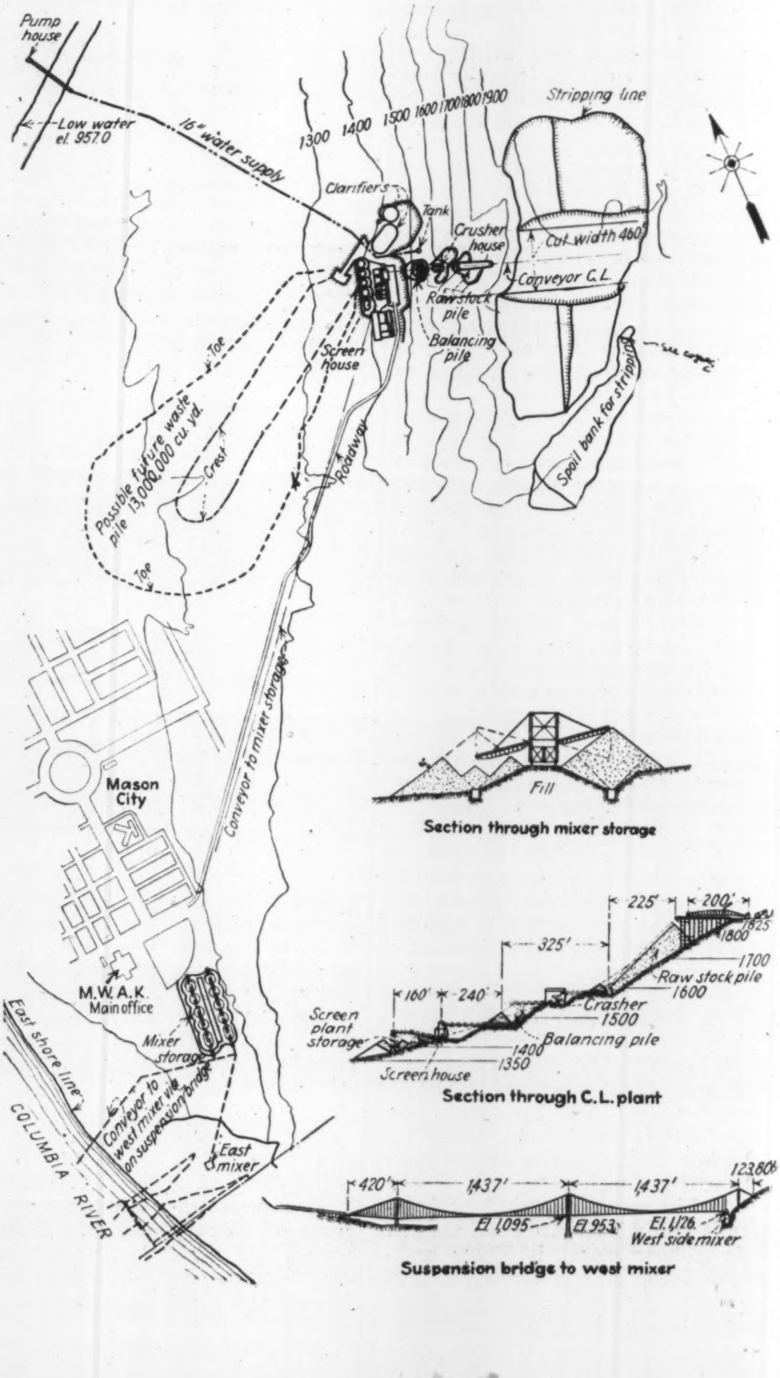
All aggregate materials are to come from the Brett Banks, 1½ miles northeast of the dam on a high mesa forming the eastern edge of the Columbia River Valley. This deposit is some 700 ft. above the general level of Mason City, is of glacial origin and contains all the aggregate sizes required in quantities far exceeding the needs of the job. Test pits, however, indicate that there are disproportionately large quantities of fines and occasional lenses of fine material—indications which suggest that the waste pile of fines will be large. The waste pile is therefore laid out to provide for 13,000,000 cu.yd.

About a dozen test pits were dug to explore the deposit, some of them to a depth of 300 ft. They show the gravel deposit to be 80 to 90 ft. above and 100 to 170 ft. below an intervening layer of fine sand. The plan is to do all the mining at present above the fine sand layer, leaving the lower strata for future use.

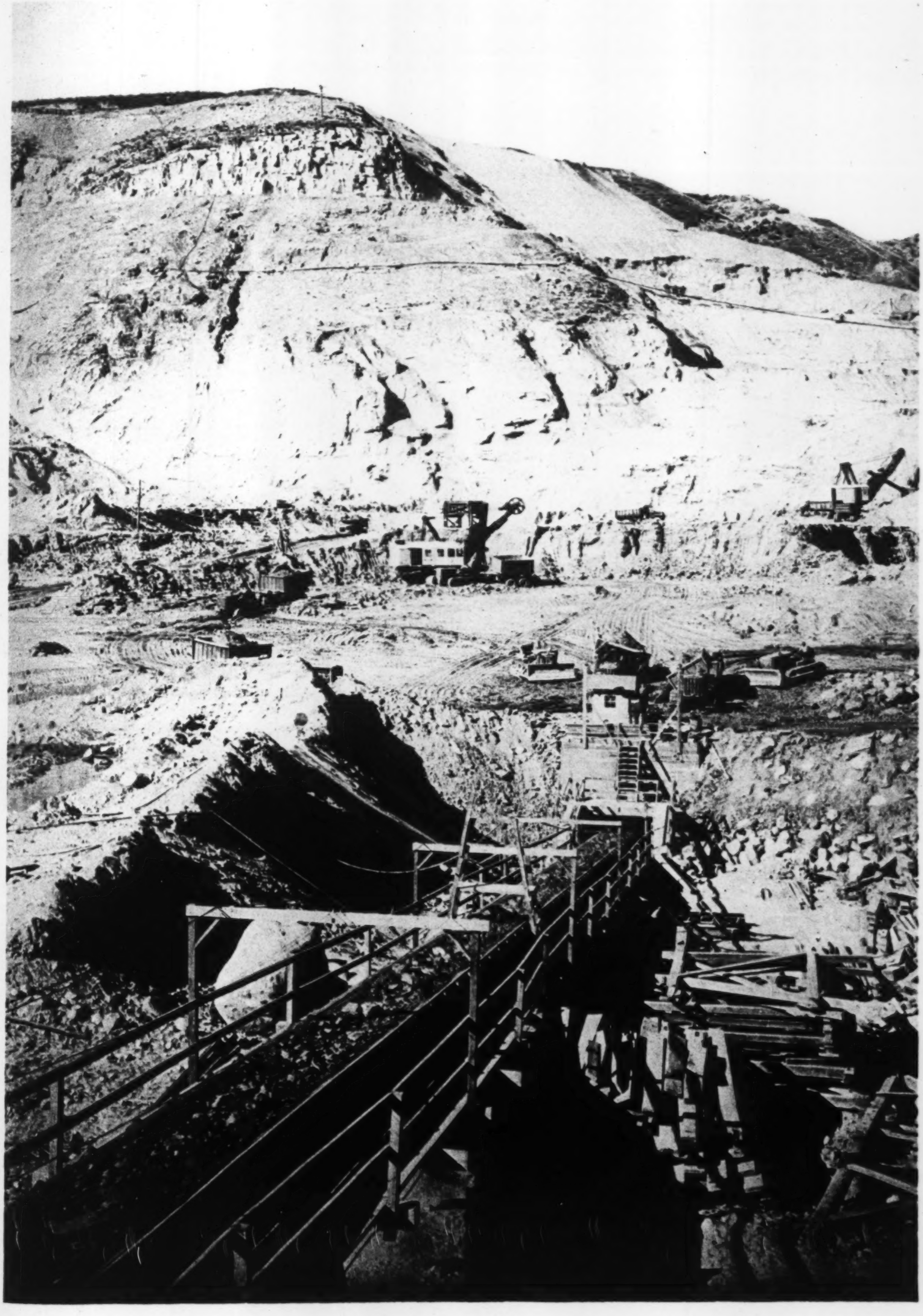
The specifications call for four sizes of gravel: (1) cobbles of screen classification between 6 and 3 in.; (2) coarse gravel between 3 and 1½ in.; (3) medium gravel between 1½ and ¾ in.; and (4) fine gravel between ¾ and ¼ in. The fineness modulus for the sand was specified at 2½ to 3. The total segregating and stockpiling capacity at the plant for all sizes is 1,000 tons per hour.

The general direction of the movement through the plant will be south, toward the main storage and mixing plants near the dam. From the stockpiles at the aggregate plant the distance of 3,900 ft. to the main storage bins will be traversed by a 48-in. belt conveyor designed to handle 1,200 tons per hour. Similarly, belts will convey materials from the main storage bins to both the east and the west mixer plants; to the latter over a suspension bridge across the Columbia River.

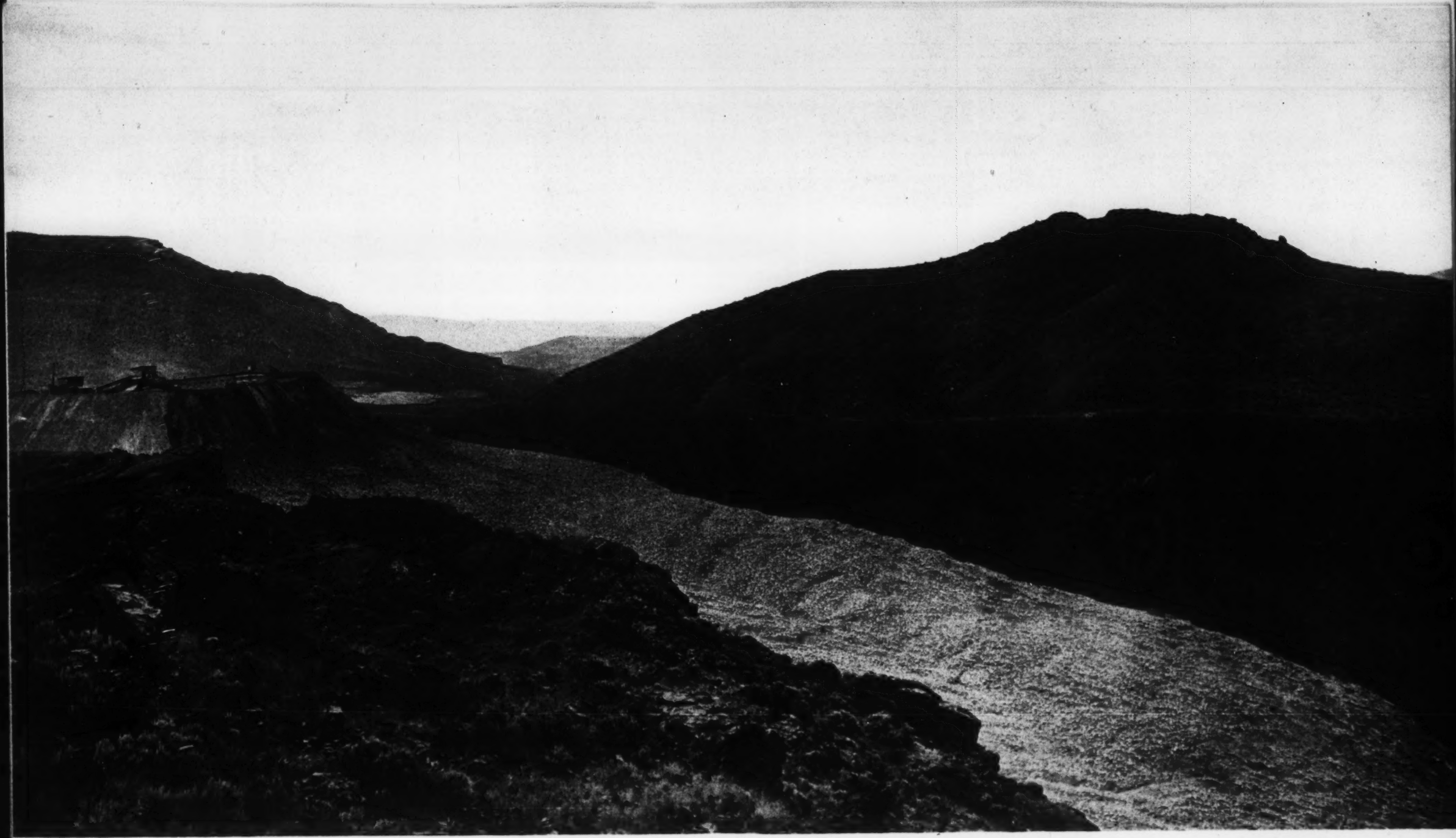
After stripping about 3 ft. of overburden which covers the deposits, the pit material is to be excavated by electric power shovels delivering to a conveyor system without intermediate haulage. A 60-in. main conveyor with


Pump house
Low water el. 957.0
16" water supply
1300
1400
1500
1600
1700
1800
1900
Stripping line
Clarifiers
Tank
Crusher house
Cut width 460'
Conveyor C.L.
Raw stock pile
Balancing pile
Screen house
Toe
Possible future waste pile 13,000,000 cu.yd.
Crest
Roadway
Spoil bank for stripping
Toe
Conveyor to mixer storage
Mason City
M.W.A.K. Main office
Mixer storage
East shore line
Conveyor to west mixer via on suspension bridge
East mixer
COLUMBIA RIVER
Fill
Section through mixer storage
225'
200'
1825
1800
1700
325'
Raw stock pile
1600
160'
240'
Crasher
1500
Screen plant storage
Balancing pile
1400
1350
Screen house
Section through C.L. plant
420'
1,437'
1,437'
123,806
El 1,095
El 953
El. 1,126
West side mixer
Suspension bridge to west mixer

AGGREGATE SUPPLY at Grand Coulee involves, besides an intricate mining, washing and classifying plant, belt-conveyor transportation of more than a mile from stockpiles to mixer bins.



Moving spoil out of west cofferdam area by a mile-long belt conveyor at a rate of 2,400 cu.yd. per hour



Spoil flowing like lava from the edge of the dump
in Rattlesnake Canyon

two 42-in. laterals will be extended into the pit as required to develop the working area. At the terminus of each lateral there will be a 200-ft. boom conveyor, one end of which will pivot on a car straddling the 42-in. belt; the other end will be mounted on powered crawlers so that the boom units can be swung in a half circle around the pivot. The shovels will load into hoppers on the ends of the booms. A grizzly above each hopper will scalp off stones too large to be handled on the belt, and a vibrating feeder will control the rate of delivery to the belt. Two booms, originally acquired for placing fill in the west cofferdam, will be used for this service. It is expected that two 40-ft. cuts over the available pit area will yield a sufficient quantity of aggregates for the present contract.

Screening coarse aggregate

The first step in the process is to scalp out and crush the oversize of 6-in. cobbles, after which the stock is stored in a balancing pile. The screening plant is arranged in identical halves, each half served by a belt from the balancing pile. Four double-decker vibrating screens on the third floor of the plant will separate the cobbles and the 3-in. gravel. On the floor below eight double-decked screens will take out 1½- and ¾-in. gravel. Washwater will be introduced ahead of the first screens. Each product will be carried by belt conveyor to the proper storage pile over a reclaiming tunnel. Quick adjustments are provided to cut out any tier of screens for repairs or for operation at part capacity. Stone ladders are provided at points of delivery, to minimize breakage of screened products.

Three sand sizes blended

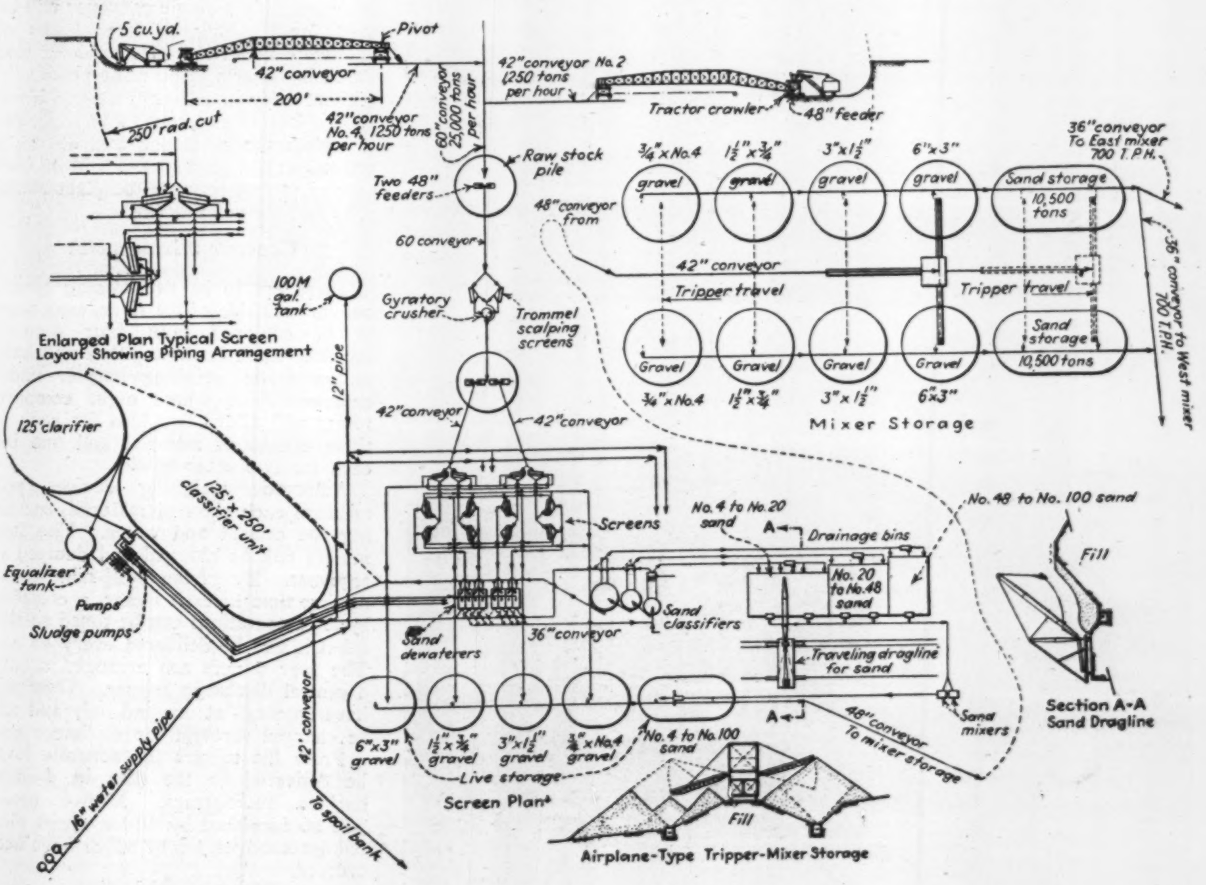
The large excess of sand indicated that grading should be done by the wet process; also this would meet all weather conditions without requiring a large screening area. Because of the high pumping head (670 ft.) and the large quantity of water required for the wet process, clarifiers were put in and washwater, after clarification, is returned to the plant system. Another thing that favored water economy was that equipment was available that could be used for stacking waste sand when dewatered.

Extreme variations in the fineness modulus of the sand were responsible for classification of this material into three sizes, which are blended into the proper proportions after draining. Sand from the last screens goes into dewatering units, where a slow-moving drag rakes the deposited sand out at the rear of the bank while the washwater flows over the forward end and thence through launders to the clarifiers. After dewatering, the excess sand is dumped in the waste pile.

The retained portion goes to a battery of three classifiers in series, and sufficient water is added to control the separations. These units will fraction the sand into three sizes: 3/16- to 20-mesh, 20- to 48-mesh and 48- to 100-mesh. The excess of any size will be discarded, and the retained portions will be stored in separate piles for drainage.

Careful provision is made to secure uniform distribution in these stockpiles by the use of automatic reversing trippers on the storage belts. Under this plan the discharging spout of the tripper moves slowly back and forth the full length of the stockpile, depositing a layer or "ribbon" of material. This process is expected to smooth out any irregularities of gradation that may result from sudden changes of feed or in the operation of the plant.

Variable-rate feeders are installed in the tunnels passing under the three drainage piles. By proper adjustment


5 cu.yd.
Pivot
42" conveyor
200'
250' rad. cut
42" conveyor No. 4, 1250 tons per hour
60" conveyor 25,000 tons per hour
42" conveyor No. 2 1250 tons per hour
Tractor crawler
48" feeder
Raw stock pile
Two 48" feeders
48" conveyor from
60 conveyor
100M gal. tank
Gyratory crusher
Trommel scalping screens
Enlarged Plan Typical Screen Layout Showing Piping Arrangement
12" pipe
42" conveyor
42" conveyor
3/4" x No.4 gravel
1½" x 3/4" gravel
3" x 1½" gravel
6" x 3" gravel
Sand storage 10,500 tons
36" conveyor To East mixer 700 T.P.H.
42" conveyor
Tripper travel
Tripper travel
Gravel 3/4" x No.4
Gravel 1½" x 3/4"
Gravel 3" x 1½"
Gravel 6" x 3"
Sand storage 10,500 tons
36" conveyor to West mixer 700 T.P.H.
Mixer Storage
125' clarifier
125' x 250' classifier unit
Equalizer tank
Pumps
Sludge pumps
Screens
No. 4 to No. 20 sand
A
Drainage bins
No. 20 to No. 48 sand
No. 48 to No. 100 sand
Fill
Sand classifiers
Sand dewaterers
36" conveyor
Traveling dragline for sand
Sand mixers
Section A-A Sand Dragline
A
48" conveyor To mixer storage
42' conveyor
To spoil bank
16" water supply pipe
6"x3" gravel
1½" x 3/4" gravel
3"x1½" gravel
3/4" x No.4 gravel
No. 4 to No. 100 sand
Live storage
Screen Plant
Fill
Airplane-Type Tripper-Mixer Storage

FLOW SHEET makes clear the intricate sequence of operations and movements gone through by concrete aggregates from pit to mixer bins.

TUNNEL IN RAVINE over which pit gravel is dumped and from which it travels on belt conveyor to the screening plant.

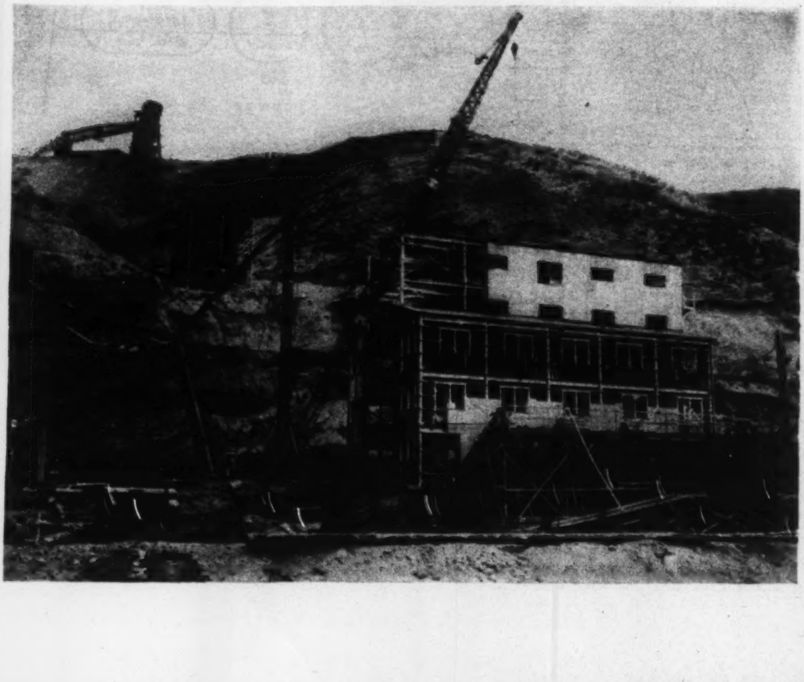
of these feeders, a finished sand, blended in the desired proportions, can be obtained. Just ahead of delivery into the final sand stockpile, a mixing device aids in the blending process by breaking up any lumps resulting from moisture in the material. In this final piling of the sand it is again stacked by automatic reversing trippers so that any irregularities in the source will be smoothed out by uniform distribution.

Aggregates brought from the plant storage piles over the 48-in. conveyor line are delivered to the main storage piles by an airplane-type tripper. To avoid breakage of material, the wings of this tripper are hinged so the material may be deposited with a minimum drop.

Flow of materials from the various plant stockpiles to the 48-in. transfer conveyor line will be controlled by remote-control gates with the control station located in the operating cab of the airplane tripper. A signal system will inform the operator of the completion of any desired gate movement.

Live storage (total of all grades) at the aggregate plant will be sufficient for nearly two shifts, figuring the requirement at 1,000 tons of finished aggregate per hour. Plant storage plus main storage will supply seven of the eight 4-cu.yd. mixers for a period of 3½ to 4 days.

SCREENING PLANT for gravel under construction at aggregate plant.



A single-belt conveyor line will deliver all grades of material from the stockpiles to bins over the mixing plants. The mixing plant on the west side of the river will have its material brought across the Columbia on a conveyor system carried on a suspension bridge, including two river spans of 1,437 ft. each. The belt will be 36 in. wide and will have a speed of 400 ft. per minute. The tower between these two spans will be mounted on a cell cluster in the west cofferdam and will extend 290 ft. above the top of the cofferdam. The suspension bridge, 3,500 ft. long anchor to anchor, is designed for a loading of 400 lb. per lin.-ft. In addition to the westbound load of aggregate, it will carry a pipe through which eastbound bulk cement will be delivered by pneumatic means from the blended cement silos on the west bank. Pneumatic delivery of the bulk cement will be for a maximum distance of about 6,000 ft. Contract has been awarded for the ten 5,000-bbl. cement silos, eight for cement as delivered from the manufacturer and two for storage of blended cement.

The belt conveyor from the stockpiles to the east side mixing plant and also that spanning the river will have a rated capacity of 700 tons per hour. Although only a single conveyor will be used for handling all five classes of aggregate materials, it is expected that the changeover will be made practically without delay in delivery; a 5-sec. blank on the belt is expected to be sufficient to switch the necessary controls, as a remote-control gate system will be used similar to that between the plant stockpiles and the main storage.

Concrete mixing plant

There are to be two mixing plants, one on each side of the river, each plant to be equipped with four 4-cu.yd. mixers. Each of these plants will have an automatic weighing batcher under octagonal bins whose eight compartments will afford two bins for each of three classes of material and one bin each for two other grades.

Automatic weighing devices will measure each class of material, including the cement and water. The four mixers will be charged and dumped in sequence. By giving a 2½-min. actual mixing time in each mixer, a complete cycle of operations can be timed so that a batch will be delivered every 45 sec. The four mixers are arranged around a central discharge hopper. They will have openings at one end only and will be charged through the discharge end.

From the mixers the concrete is to be delivered to the dam in 4-cu.yd. buckets on flatcars. Motive power will be furnished by 10-ton diesel electric locomotives, ten of which have been ordered.

Heavy Rainfall and Floodflows in New York Area

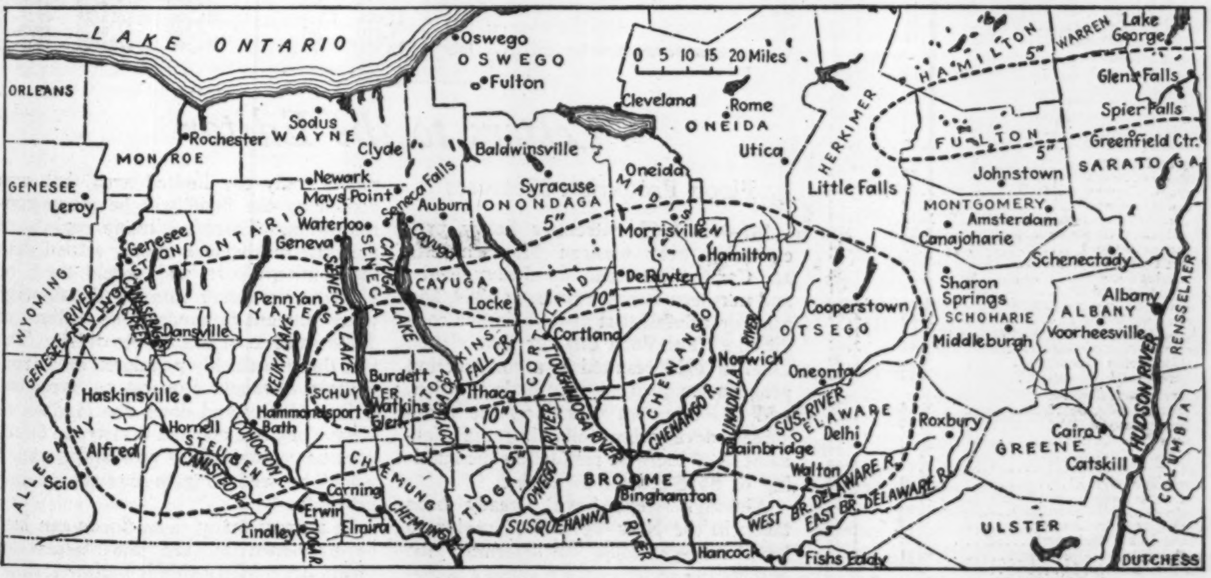
Unusually heavy precipitation, most of which occurred in one 24-hour period, resulted in many record-breaking stream discharges

FULLER COMPILATION of the rainfall records for New York during the period of July 6 to 11 reveals an exceptional precipitation, spread over a wide area, in which 5 in. or more of rain in one day was general. The maximum rainfall in 24 hours was 8.52 in. at Delhi; Cortland with a 24-hour precipitation of 7.67 in. had the greatest total rainfall, 11.54 in. An interesting detail observation is the report of James P. Wells, consulting engineer, Rochester, that several farmers between Ithaca and Watkins Glen told him of having found 10-qt. pails running over on the day following the first of the heavy rains in their locality.

Many of the streams in the region reached new high levels due to the rapid runoff from the hilly agricultural land. At Hammondsport, Glen Creek, draining an area of 5.2 miles, received 1,150 sec.-ft. of runoff per square mile, and the runoff per square mile in Steele Brook, at Delhi, with a drainage of 5.4 miles, was 648 sec.-ft. Fall Creek at Ithaca, draining 124 square miles, and the Owego River at Owego, with a catchment basin of 186 square miles, were discharging almost four times greater volumes than any previously recorded flows. Records from the U. S. Geological Survey, Water Resources Branch, and the U. S. Weather Bureau have been tabulated on p. 162, to show

WASHOUT of 150-ft. tower in the gorge at Watkins Glen caused the collapse of two plate-girder spans of this New York Central R.R. viaduct.

INADEQUATE CULVERT CAPACITY for a swollen stream occasioned this road washout on Route 41, north of Greene.


LAKE ONTARIO
Oswego
OSWEGO
Fulton
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Cleveland
Rome
ONEIDA
Utica
HAMILTON
WARREN
Lake George
Glens Falls
Spier Falls
Greenfield Ctr.
SARATOGA
FULTON
Johnstown
5"
HERKIMER
Little Falls
MONTGOMERY
Amsterdam
Canajoharie
Schenectady
ORLEANS
Sodus
WAYNE
Rochester
MONROE
Clyde
Baldwinsville
Newark
Mays Point
Seneca Falls
Syracuse
ONONDAGA
GENESEE
Leroy
Auburn
Oneida
MADISON
Morrisville
Hamilton
DeRuyter
Waterloo
Geneva
Cayuga
ONTARIO
LIVINGSTON
Genesee
SENECA
CAYUGA LAKE
CAYUGA
Locke
CORTLAND
10"
Cortland
CHENANGO
Norwich
Cooperstown
OTSEGO
Sharon Springs
SCHOHARIE
Middleburgh
ALBANY
Albany
Voorheesville
RENSSELAER
WYOMING
GENESEE RIVER
CANASERAGA CREEK
Dansville
Penn Yan
YATES
SENECA LAKE
KEUKA LAKE
TOMPKINS
FALL CR.
Ithaca
Burdett
SCHUYLER
Watkins Glen
Hammondsport
Bath
Haskinsville
Hornell
Alfred
STEUBEN
COHOCTON R.
CANISTEO R.
ALLEGANY
Scio
Corning
Erwin
Lindley
TIOGA R.
Elmira
CHEMUNG
CHEMUNG R.
CAYUGA CR.
70"
5"
TIOGA
OWEGO
RIVER
TOUGHNIOGA RIVER
BROOME
Binghamton
SUSQUEHANNA RIVER
CHENANGO R.
UNADILLA RIVER
Oneonta
SUS. RIVER
DELAWARE
Delhi
Bainbridge
Walton
WEST BR. DELAWARE R.
EAST BR. DELAWARE R.
Roxbury
GREENE
Cairo
Catskill
HUDSON RIVER
COLUMBIA
ULSTER
Hancock
Fishs Eddy
DUTCHESS

ISOHYETAL LINES of total precipitation in five days show the wide distribution of heavy rainfall in the New York flood territory.

in detail the rainfall and stream data of the affected region.

J. C. Fisher, meteorologist, U. S. Weather Bureau, Ithaca, furnished the isohyetal lines shown in the map.

Storm origin traced

Meteorological data analyzed by T. E. Reed, U. S. Weather Bureau, Binghamton, N. Y., led to the conclusion that a rare combination of storm movements caused the excessive rains in the Southern Tier counties on July 7 and 8. Ten days previous, a low-pressure area in Alberta, Canada, moving slowly eastward, left in its wake an extensive region of high barometric pressure. This barrier of cool air effectively blocked the northeast movement of two low-pressure centers starting in Montana and Nevada on July 1 and 3, respectively, and deflected these storms so that they circled south around the Great Lakes into central New York. Meantime, coming toward the same region, were three areas of high pressure, which originated in the Atlantic Ocean and southern states. The simultaneous convergence of the five storm centers brought about the dispersion of an unparalleled rainfall.

TABLE 1—RAINFALL RECORDS IN CENTRAL NEW YORK, JULY 6-11, 1935

	In. Rainfall	
	Total	Max. 24 Hr.
Western Plateau		
Alfred (Alleghany Co.)	6.64	5.58
Andover (Allegany)	6.86	3.38
Angelica (Allegany)	6.06	3.39
Scio, Allegany	4.64	3.85
Elmira (Chemung)	2.07	1.56
Haskinville (Steuben)	7.71	6.70
Woodhull (Steuben)	2.46	1.55
Eastern Plateau		
Binghamton (Broome)	1.82	0.92
China (Delaware)	3.82	1.65
Cooperstown (Otsego)	6.52	4.49
Cortland (Cortland)	11.54	7.67
Delhi (Delaware)	9.45	8.52
Leonardsville (Madison)	4.56	2.05
De Ruyter (Madison)	4.09	2.25
Morrisville (Madison)	5.73	3.04
Oneonta (Otsego)	7.12	6.71
Roxbury (Delaware)	3.68	1.85
Sage Brook (Chenango)	7.33	3.96
Sherburne (Chenango)	5.09	3.56
Bainbridge (Chenango)	5.68	4.10
Shaekham (Cortland)	6.32	2.58
Hudson Valley		
Albany (Albany)	3.19	2.08
Cairo (Greene)	6.66	3.52
Oak Hill (Greene)	3.77	2.35
Conklingville (Saratoga)	5.58	4.73
Greenfield Ctr. (Saratoga)	5.15	2.80
Mechanicville (Saratoga)	3.40	1.89
Mount McGregor (Saratoga)	9.32	4.70
Spier Falls (Saratoga)	8.57	4.49
Feeder Dam (Saratoga)	9.75	5.00
Ashley (Washington)	5.04	3.42
Schaghticoke (Rensselaer)	3.27	1.67
Johnsonville (Rensselaer)	3.17	1.74
Voorheesville (Albany)	3.61	2.95
North Creek (Warren)	3.67	1.33
Warrensburg (Warren)	9.30	3.53
Mohawk Valley		
Dolgeville (Herkimer)	7.29	4.87
Gloversville (Herkimer)	4.47	2.10
Little Falls (1) (Herkimer)	4.89	3.35
Salisbury (Herkimer)	5.75	3.20
Sharon Springs (1) (Scholarie)	5.03	3.21
Schenectady (Schenectady)	3.40	2.01
Trenton Falls (Oneida)	4.04	1.85
Utica (Oneida)	3.53	3.28
Tribes Hill (Montgomery)	5.11	3.63
Stewarts Landing (Fulton)	10.07	5.96
Sprite (Fulton)	6.39	4.10
Ephratah (Fulton)	4.21	2.76
Pecks Pond (Fulton)	6.31	5.99
Great Lakes		
Fulton (Oswego)	3.16	2.80
Oswego (Oswego)	2.07	.63
Cleveland (Oswego)	2.96	2.30
Rochester (Monroe)	2.42	2.13
Clyde (Wayne)	2.82	1.18
Newark (Wayne)	2.30	1.09
Central Lakes		
Auburn (Cayuga)	1.88	.99
Cayuga (Cayuga)	2.51	1.23
Avon (Livingston)	2.32	2.02
Dansville (Livingston)	5.37	3.69
Hemlock (Livingston)	1.22	.75
Geneva (Ontario)	2.68	1.44
Mays Point (Seneca)	1.99	.87
Waterloo (Seneca)	2.68	1.54
Ithaca (Tompkins)	9.59	7.01
Letchwork Park (Wyoming)	2.41	1.30
Penn Yan (Yates)	5.43	4.08
Skaneateles (Onondaga)	3.04	1.36
Syracuse (Onondaga)	3.62	2.61
Baldwinsville (Onondaga)	3.44	2.90
Brewerton (Onondaga)	7.55	6.82
Adirondack Region		
Herrings (Jefferson)	2.58	1.70
Copenhagen (Lewis)	4.26	4.02
Lyons Falls (Lewis)	3.73	1.81
Boonville (Oneida)	2.95	1.85
Sperryville (Lewis)	3.94	1.82
Eagle Falls (Lewis)	4.10	2.13
Stillwater Reserv. (Herkimer)	2.81	1.29
Raquette Lake (Hamilton)	1.50	.70
McKeever (Herkimer)	3.53	1.46
North Lake (Herkimer)	2.88	1.37
Inghams Mills (Herkimer)	6.51	4.73
So. Edwards (St. Lawrence)	4.50	2.79
Port Henry (Essex)	2.44	0.93

TABLE 2—STREAM DISCHARGES IN CENTRAL NEW YORK, JULY 8-11, 1935

Stream	Place	Date	Peak in Sec.-Ft.	Drainage Area	Peak Sec.-Ft. per Sq. Mile	Previous Maximum Flow	Date	Period
Present Gaging Stations								
Genessee River	Scio	July 8	7,480	309	24	10,600	5/22/19	1916–35
Genesee River	St. Helena	July 9	17,400	1,017	17	44,400	5/17/16	1908–35
Canaseraga Creek	Dansville	July 8	10,000	153	65	6,900	11/30/27	1910–12
Tioga River	Lindley	July 8	4,060	770	5	15,800	4/ 1/32 8/24/33	1930–35
Tioga River	Erwins	July 8	47,200	1,370	34	46,700	5/22/19	1918–35
Cohocton River	Campbell		22,000	472	47	12,900	12/ 1/27	1918–35
Chemung River	Chemung	July 9	80,000	2,530	32	67,000	3/15/18	1903–35
Fall Creek	Ithaca	July 8	25,000	124	202	6,290	11/16/26	1925–35
Owego River	Owego	July 8	20,000	186	108	5,690	4/ 1/34	1930–35
Tioughnioga River	Itaska		44,000	735	60	12,500	4/ 1/34	1929–35
Chenango River	Chenango Fks		70,000	1,490	47	35,500	3/27/13	1912–35
Susquehanna River	Conklin	July 9	46,600	2,240	21	52,000	3/28/13	1912–35
Sage Brook	So. New Berlin	July 8	200	0.69	290	23	6/19/34	1932–35
Unadilla River	New Berlin	July 8	2,320	196	12	5,590	3/15/29	1924–35
Susquehanna River	Colliersville	July 9	3,010	351	9	5,190	3/16/29	1924–35
W. Br. Delaware River	Hale Eddy	July 8	17,200	593	29	26,500	9/30/24	1912–35
Discontinued Gaging Stations								
Canisteo River	West Cameron		20,000	342	58			1930–31
Unadilla River	Rockdale		9,810	518	19	10,400	10/ 7/32	1929–33
Oaks Creek	Index		458	103	4	1,060	4/12/32	1929–32
Cherry Valley Creek	Westville		655	81	8	1,780	4/11/31	1930–31
Other Points								
Glen Brook	Hammondsport		over 6,000	5.2	1,150			
Butternut Creek	Enfield Glen		7,500	26.8	280			
Six Mile Creek	Ithaca		4,500	47.8	94			
Cascadilla Creek	Ithaca		1,650	12.8	129			
Tioughnioga River	Homer		1,100	71.5	15			
Tioughnioga River	Cortland		1,350	100	14			
Steele Brook	Delhi		3,500	5.4	648			
East Brook	Walton		4,220	23.5	180			
Maximum Discharges at Other New York Gaging Stations								
Allegheny River	Red House	July 10	3,710	1,694	2	41,000	3/ 2/10	1903–35
Oswego River	Oswego	July 11	15,200	5,121	3	16,400	4/15/34	1933–35
E. Br. Delaware River	Fishs Eddy	July 8	3,180	783	4	53,300	8/24/33	1912–35
Delaware River	Port Jervis	July 9	30,100	3,076	10	15,500	10/10/03	1904–35
Neversink River	Oakland Valley	July 9	1,640	222	7	20,000	8/24/33	1928–35
Roundout Creek	Rosendale	July 8	12,600	386	33	27,300	8/27/28	1926–35
Wappinger Creek	Wappinger Falls	July 9	74	182	0.4	5,950	3/ 5/34	1928–35
Hudson River	North Creek	July 9	6,840	792	9	27,400	3/27/13	1907–35
Hudson River	Hadley	July 9	11,300	1,664	7	33,100	4/12/22	1921–35
E. Br. Sacandaga R.	Griffin	July 9	3,200	114	28	2,620	4/17/34	1933–35
Sacandaga River	Hope	July 9	10,500	491	21	32,000	3/27/13	1911–35
East Stony Creek	Northville	July 8	1,670	89	19	1,670	4/17/34	1933–35
Kayaderosseras Creek	W. Milton	July 8	2,700	90	30	2,350	3/16/29	1927–35
Batten Kill	Battenville	July 8	9,470	394	24	21,300	11/ 4/27	1922–35
Hoosic River	Eagle Bridge	July 8	7,680	510	15	29,800	11/ 4/27	1910–35
Mohawk River	Little Falls	July 8	17,000	1,348	13	21,300	3/15/29	1927–35
East Canada Creek	Dolgeville	July 8	6,010	261	23	8,500	4/ 8/28	1927–35
West Canada Creek	Kast Bridge	July 8	10,300	556	19	16,500	6/21/22	1920–35

◆

Letters to the Editor

Flood Protection Measures

Sir—In 1869 extremely heavy precipitation over western Massachusetts and Connecticut resulted in heavy floods, and northern Pennsylvania, in 1889, had a heavy rainfall that caused similar conditions. The flood disaster that visited Ohio in 1913 resulted in a construction program to prevent future destruction, and less than ten years ago the widespread devastation following the Vermont flood likewise resulted in the building of flood-protection works.

Although steps have already been taken in the New York flood region to have surveys made to determine the best means of preventing similar occurrences, only the limited area that was visited by the flood will be given consideration. There are many regions of the state much more thickly settled than the southern part, and should these be visited by a heavy rainfall, the damage would amount to hundreds of millions of dollars and considerable loss of life. The fact that the thickly populated area from Buffalo through Rochester, Syracuse, Utica, Albany and down the Hudson to New York has not had disastrous floods does not obviate their possibility, and it would be well to give thought in this direction.

In a great many cases floods can best be prevented by the construction of reservoirs. When this is impractical, an alternative is to increase the capacity of the present stream channels. However, it is the height of folly to do this flood-protection work solely in the areas that have had disastrous floods. These measures should be carried out throughout the entire country.

Rochester, N. Y., July 23, 1935.
JAMES P. WELLS,
Consulting Engineer.

Design of Dome Structures

Sir—R. McC. Beanfield is to be highly commended on his article, "Unique Design and Construction of Steel Ribbed Domes," appearing in the May 9 issue of your paper. The featured method of design not only breaks away from the unjustifiable conservatism of American design practice in hesitating to adopt new thoughts and discoveries but represents delightful originality. In the described dome for the Griffith Planetarium, where continuity was the requirement for necessary rigidity, the principles of design as originated for reinforced-concrete domes were well applied, particularly the method developed by Professor Dischinger for stress distribution in thin concrete shell domes under unsymmetrical loading conditions. To your paper (*ENR*, Feb. 21, 1929) belongs the credit for giving the first reference to this method in this country. A. Floris in a very ably written discussion (*Transactions*, Am. Soc. C. E., 1930, p. 1175) outlines Dischinger's method of stress analysis on shell domes based on a sine law for anti-symmetrical wind loads.

Inadvertently a statement is made in Mr. Beanfield's article which does not conform with discoveries made since Dischinger's method was first presented —namely, that "The polygonal-ribbed type dome with ring framing has an advantage over the spherical shell in that the ribbed dome can be supported directly by columns at each rib, whereas the spherical shell must have continuous support around its base." The problem of the carrying capacity of a thin monolithic shell dome of revolution with the absence of support to the dome between columns has since been solved and made the subject of a paper. ("Statik and Dynamik der Schalen" by Dr. Ing. Fluegge, Springer, 1934.) Dischinger shows that in a spherical dome whose springing line is horizontally stiffened, if loaded between columns along the free edges with uniformly distributed meridional forces, the lever arm of the resisting internal forces in the shell is dependent only upon the column spacing. This proportion of effective beam depth to span causes stresses to be quite independent of the span, as in diaphragms or wall-like beams the height of which is very great in comparison to the span. Such a hemispherical thin shell concrete dome, supported at eight points, has actually been built here in the United States for the Hayden Planetarium of the Museum of Natural History in New York (*ENR*, July 25, 1935). This reversal of structural material used for supports and dome in the Griffith and Hayden planetariums is also very interesting—that is, steel dome and concrete supports in the former, concrete dome and steel supports in the latter.

Chicago, Ill., May 14, 1935.
J. E. KALINKA,
Chief Structural Engineer,
Roberts and Schaefer Co.

Melting Snow and Floods

Sir—Referring to the article on "Snow Surveys as an Aid to Flood Forecast and Control," by J. E. Church, in your issue of June 20, 1935, no mention whatever is made of climatic conditions, which I think is an important factor in western Canada and the northern United States. For example, one of the worst floods on record occurred in the Columbia and Fraser Rivers in June, 1894, following a late cold spring which was broken on May 24 by warm weather and rains. In other years there has been as much, if not more, snow in the mountains than there was in 1894, but early short thaws would alternate with cold weather, keeping the river stage down until all of the snow in the lower levels disappeared, so that there was no inundation. The point that I wish to make is that there is always plenty of snow in the mountains to cause flooding, provided that the snow melts rapidly and continuously. This is hardly possible in the early spring, so that what we should fear is a late cold spring followed by continuous warm weather with rain.

Winnipeg, Man., Canada, June 27, 1935.
J. G. SULLIVAN,
Consulting Engineer.

Details for Damp-proof Walls

Sir—Your description of the Techwood housing project (*ENR*, July 4, 1935, p. 7), will be most interesting to many of your readers who have had to do with building construction. The landscaping and setting of the different units have been beautifully arranged, so that the general impression of the development after a few years will be good.

As for the structural design of the buildings, as evidenced by the cross-section which you show, I cannot say so much. The side wall is 4-in. common brick outside with 8-in. tile backing. The concrete floor slab extends through the tile to the back of the brick. The writer has used this type of wall construction in commercial buildings, and has observed the same type of construction in many other buildings during the last twenty years. In nearly every case that has come to his observation, the wall has been unsatisfactory. The joint between the brick and tile will not be completely bonded and filled with mortar. In driving storms, water will penetrate and drip downward though the tile. The concrete slab would stop this downward course of the water and conduct it into the room at the floor level. In one particular instance a combination wall, with 4-in. brick and 12-in. tile backing with a coat of asphaltic waterproofing and plaster bond and 1 in. of three-coat gypsum plaster leaked very badly. It was necessary to apply several coats of waterproofing on the outside walls before this leakage could be permanently stopped.

It has been the custom of engineers and architects to lay conditions of this kind to poor work on the part of the contractor when, as a matter of fact, they result from a poor structural design.

The lintels over the windows, and I suppose over the doors, are formed with steel angles, one for the brick and two for the tile. This arrangement provides no waterstop over the masonry openings, which is believed desirable in all outside masonry walls. Seepage down through the masonry will show on the soffit of the opening and drip to the sill on the inside of the sash. For lintels in brick and tile walls the writer has used small I-beams with a steel plate very nearly equal to the width of the wall, spot-welded to the bottom flange of the beam. The cost of the beam and the plate would not be greater than for the sections shown.

When steel sash is used, a jam bar should be welded to the plate to receive the same. The section indicates that the lower rail of the sash is set back of the masonry sill. Here is another source of trouble. The pressure of the wind and the action of the sun will, after a few years, develop a hair crack along the edge of the sash rail through which water will have access to the interior of the wall. A sill 2-in. wider with a rebate to receive the lower rail of the sash would obviate this difficulty. Sills of common brick are not practicable in a permanent structure. Every ten or twelve years the joints in the brick work will have to be repointed, in order to keep water out of the wall.

The coping on the wall at the roof line is indicated to be of concrete, presumably of reinforced concrete. The different expansions of concrete and brick will, after a few years, break the bond between the coping and the brick work. This will make leakage under the coping and into the wall very probable.

This difficulty would be largely overcome if the coping were set to overhang the wall at least an inch and if a membrane flashing were placed between the brickwork and the coping, extending back into or over the roof covering. This must not be a part of the roof covering nor fastened to it or the roof slab.

Groton, Conn., July 8, 1935.
G. L. BILDERBECK,
Consulting Engineer.

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Aug. 1, 1935

A Construction Classic

GRAND COULEE DAM construction is made the theme of this issue of *Engineering News-Record* because of the notable working methods that have been put in practice in that undertaking. Their originality gives full proof of the skill, resourcefulness and organizing ability of the American contracting profession. No more impressive evidence could be asked of the vital bearing of imagination and broad perspective on the development of a construction program than is contained in the detailed story set forth in the present issue. Especially when read with the performance on the now nearly completed Boulder Dam in mind, it shows that in planning field execution creative engineering reaches as great heights as in the activities of the designing engineer when he originates and develops his conception. The record of Grand Coulee brilliantly confirms the Boulder Dam demonstration of what can be accomplished by thoroughness in working out procedure and plant and wise liberality in installing equipment. The work recounted takes rank among the construction classics. Its completion at the pace now set bids fair to make it a model of successful construction attack.

The Power Dam Abandoned

AT THE SAME TIME that the dam construction methods are studied, notice should be taken of the recent far-reaching modification of the project. Eight months ago, when Grand Coulee Dam was described in these pages (*Engineering News-Record,* Nov. 29, 1934, p. 683) it was a power-generating project of dubious character. What we said at that time of its economic justification, and on a later occasion (Jan. 3, 1935, p. 23) of its engineering aspects, is now fully disposed of. The present dam, which in effect is nothing more than a dam foundation, will generate no power, which does away with the economic paradox of building a huge power project in a market already greatly oversupplied. Also, when the time comes to raise a full-height dam on this foundation, to supply Columbia Basin irrigation, it can be done without the hazards that were inherent in the earlier low dam scheme. Under the earlier plan there was no prospect of making the ultimate high dam an integral structure. Instead it would have been necessary to erect a wall 200 ft. high on top of the original low dam and find a way of strutting this wall against the foundation toe securely enough to resist a tremendous water pressure at great height above the foundation. To do this and at the same time take care of shrinkage, leakage and internal rending water pressures would have been a task of difficulty and risk. Under the plan now adopted the project reverts to the time-tried method of resting a dam on an adequately strong level foundation bed. Whether the high dam is built in five years or fifty, it will find a dependable base ready for it. And the contractor's efficient and original construction planning gives fair assurance that this base will be an economical investment for the intended purpose.

Earthmoving by Factory Process

TWO FEATURES dominate the Grand Coulee job as it has developed up to now, the large-scale use of cellular cofferdam construction, and the huge belt-conveyor system that moves the spoil from pit to dump. For boldness the cofferdam can hardly challenge the pioneer position occupied by the cofferdam of the "Maine," but in size, service demands and skillful adaptation to complex requirements it is second to none. But in sensational character it is surpassed by the conveyor system, which represents a transfer of factory mechanism and process to the construction site. In kind it is not new, though rare; but here it has been extended to a size and capacity so far overshadowing earlier applications in construction as to represent radical innovation. The huge belt is moving earth at a yardage rate comparable with that of Stevens' great railroad plant in the Culebra Cut, the key to the Panama Canal achievement. And in weighing this comparison it should be noted that dirt trains on a railroad track can be bypassed when a car or a track goes wrong, while the conveyor has no sidings but must keep going or tie up the job. As the record shows, it has done so with remarkable steadiness. Contractor and builder deserve credit for having the courage to believe that this result could be attained.

State Planning

AN INDICATION of how the idea of studying regional resources has taken root since the national planning movement was initiated under the Public Works Administration is furnished by a list recently compiled in the office of the National Resources Board. Resource study meant little to the states before the latter part of 1933, only a few minor technical departments of the state governments being concerned with it; but under the stimulus of the assistance rendered by the national board most of the states set up competent bodies for the purpose. Wider acceptance of the resource study and planning principle has since developed. This is gratifying, for state planning has much to its credit even though its tangible achievements are few. Of course there can be no practical results until adequate data on resources have been compiled and analyzed. While a good beginning has been made in this work, it is only a beginning. Even the initial data, however, have enabled many state officials and legislators to realize how much light they throw on development problems. In this new understanding lies the significant accomplishment of the state planning movement to date.

Street Paving Delays

MERCHANTS IN MILWAUKEE whose places of business face on streets torn up for repaving are complaining about the delays and the apparent lack of coordination among utilities in caring for underground facilities. In some cities a way has been found to pool interests sufficiently to set up jointly a committee or staff to do this coordination; when a pavement is to be laid, this committee proceeds to arrange a schedule of operations long before the actual paving job begins. Such procedure avoids repeating the experiences of earlier years, when a pavement was hardly down before some utility had to rip it up to provide taps or changes necessary for the service of the growing community. It is the practice of many cities not to allow a street to be torn up for five years after paving except in emergencies, which in these days may be a pretty small item. Prohibition alone is not particularly effective, however. The true answer to pavement-opening problems is for city councils to authorize the engineers in charge of paving to work out definite schedules, or else for utilities voluntarily to support a common staff for the purpose.

Confusion in the Works Program

HOW is the works program going forward? The question is inspired by rapidly-growing public alarm over the apparent stagnation of the undertaking. A partial answer is given by some notes from current observation of Washington doings.

1. Confusion is fully as pronounced as a month ago. It affects government departments as badly as the rest of the country.

2. Practically no new employment has been produced.

3. It is unlikely that there will be much employment before late fall; only a few weeks ago August seemed a fair guess, then September, but it now looks like October or November. If matters keep drifting along as they are now doing, the date may be moved along still farther.

4. A major cause of confusion is the same conflict between relief and work aims that has dominated the works-program situation for months.

5. The promised transfer of direct relief to local authorities has not yet been made and is not in sight. That this fundamental approach to cleaning up the relief situation is still in the future appears mainly chargeable to fumbling the assignment of getting jobs going. Relief-roll malingering is still denied, but the denial finds little belief.

6. Many problems affecting the program are still unsolved. Fundamental principles necessary to its successful execution remain to be formulated and announced.

7. Quick projects in adequate number ready for execution are badly lacking, due to indefinite policies.

8. The $25,000 limit that was supposed to mark off PWA from WPA is not working, because not consistently adhered to, which increases confusion.

9. Mendicancy on the part of greedy communities seeking free government money complicates the situation. Some states and cities with projects available for PWA loans are holding back to see whether they can dodge the cost by getting WPA to build them. Atlanta wants a $4,000,000 sewer project built by WPA relief labor. New York State wants flood repair free by government money and a flood-protection survey conducted by army engineers. The Administration does not discourage such attempts. WPA offers to do the Atlanta job if the city will pay for half the materials, against the claim that the project should be done under the PWA grant-and-loan system. The New York State request is promptly acceded to. No safeguard has been set up against such attempts to graft on the emergency relief fund.

10. Inertia at the very top is *the* prime cause for lack of progress. In some quarters it is charged that the program is being held up for political reasons. Tangible evidence for this charge is not discoverable, but there is little doubt that the confusion would disappear overnight if the President would issue driving orders.

11. The works-program machine is not geared together. Because of its three-piece organization it is headless with respect to planning. Action is fatally delayed because the President himself must dot every *i* and cross every *t*.

12. No ordinary business, much less a construction enterprise incomparably greater than any ever before attempted, could function with the lack of organization that characterizes the works program.

13. In highways the present verdict is that there will be little doing before mid-September. Reason: For six months plans and programs have been developed and redeveloped, but they now turn out to be largely useless because they will not fit the new rules, which rules could not be drafted until three weeks ago for want of prescribed overhead policies.

14. Conflicting statements and instructions stall progress and paralyze the efforts of those who could be producing results. Example: After the President declared outspokenly that restrictive rules will not apply to grade-crossing work, no actual order to this effect was issued to the Bureau of Public Roads. Result: Grade-crossing regulations are promulgated which practically mean that no work of the kind will be done.

15. There are some bright spots in the present picture: At present everyone is working feverishly to find quick projects, so far badly wanting. There is hope that developments will move toward the establishment of a safeguarding principle against budgetary work by WPA. The mathematical obsession of putting $3\frac{1}{2}$ million relief-roll clients into jobs at $1100 per man and the practice of ignoring total employment may yet go by the board. These, of course, are only hopes.

16. A tangible bright spot is the volume of grant-only projects that are going through PWA, which in effect will increase the four-billion-dollar fund. Decentralization of PWA by putting project examination complete into the state offices is also bringing about much faster progress on PWA applications.

TAKEN together these observations paint a thoroughly discouraging picture. They mean that, if the whole responsibility for the works program is left with Washington, it faces utter demoralization. Mismanagement and foggy purposes are major factors in this tragic situation.

A very real responsibility rests on citizens and officials out through the country to prevent the collapse of the program. They have three lines of action: to cooperate in planning projects, both of PWA and of work-relief type; to demand through their representatives that clear and complete policies be laid down at once and the entire machinery put at full speed ahead; and to insist that the program be cleaned up by confining WPA's work-relief activities to non-budgetary work and by putting an end to all forms of relief-roll grafting.

CURRENT NEWS

Ruling Concerning Foreign Materials Held Beneficial

(Washington Correspondence)

PWA met the steel industry's protest by offering to rescind its ruling which requires borrowers from its public works fund to buy foreign construction materials if the price on orders of $10,000 or more is 15 per cent less than the lowest bid of an American firm. With President Roosevelt's emphatic support for its policy, however, PWA is not likely to rescind the order.

The rule was issued May 25, just two days before the Supreme Court's decision on NIRA. Certificates of code compliance which had afforded protection against foreign competition on federal projects under NIRA could no longer be demanded of bidders on any projects. PWA invoked the Johnson "Buy American" Act and fixed a differential of 15 per cent on large orders that it hopes will shut out foreign competition, but admittedly is designed to prevent steel prices from going too high, thus reducing the volume of public works construction and employment created by such projects. On orders between $100 and $10,000 the differential is 25 per cent; under $100 it is 100 per cent.

Apprehensive concerning the possible effect of concessions made in reciprocal tariff agreements, the steel industry is nervous. No foreign steel has been used in any PWA projects, with the exception of some Belgian pipe that an Oregon town had on hand and was given permission to use.

In the past two years domestic mills have received orders for $179,000,000 in iron and steel products, not including machinery, for projects financed by PWA. Labor employed is estimated by the U. S. Bureau of Labor Statistics at 246,000,000 man-hours in mining, transportation and manufacture.

Foreign competition not expected

PWA doesn't expect its rule to invite foreign bids, although there is a report that German competition is feared on a New York project. If any substantial volume develops, the White House may intervene.

If foreign competition shows its head in the public works program, it will be in structural shapes, concrete reinforcement bars and sheet piling. Total imports of such items in five months this year, as compared with last, were: structural shapes, 13,087 tons; 1934, 8,081 tons; reinforcing bars, 508 tons; 1934, 417 tons; sheet piling, none; 1934, 443 tons. Exports of iron and steel products this year exceed imports by a ratio of 5 to 1.

Ruling increases tariff

President Roosevelt defended PWA's ruling by explaining that the 15 per cent differential in favor of the domestic manufacturer adds that much to the fairly high tariff protection accorded by various previous administrations as sufficient to offset lower costs abroad. The President didn't refer to the fact that depreciation of the dollar has increased tariff duties against France and Belgium, which are still on the gold standard. He represented, however, that the statutory rates have not been reduced except on items of minor importance.

Lower Colorado River Project Assured by Agreement

Contracts have been signed by the government and the Lower Colorado River Authority clearing the way for construction of the $20,000,000 Lower Colorado River project in Texas. One contract between PWA and the Authority provides for the purchase by the government of not more than $10,500,000 revenue bonds of the Authority and a grant of 30 per cent of the cost of labor and material, but not to exceed $4,500,000. A second agreement between the Secretary of the Interior and the Authority covers an additional $5,000,000 to be spent by the Bureau of Reclamation on the project, largely on flood control and irrigation phases. The project includes completion of a dam near Bluffton, Tex., and a unified system of new dams and reservoirs to afford flood control, hydroelectric power and the irrigation of 120,000 acres of rice land 90 miles below Austin. It originated as a private enterprise but has been taken over by the Authority. Power and water revenue will repay the cost of the project which will employ about 4,400 men.

Roosevelt Requests Action On Parker Dam Bill

President Roosevelt's request for action on the Johnson bill validating Parker Dam and other water control projects affected by the U. S. Supreme Court's decision in litigation between the federal government and the state of Arizona may bring the bill out of the House Rules Committee to a vote on the floor without further delay. The President said on July 26 that he had requested Rep. O'Connor, committee chairman, to act on the bill that has been held up in the committee for several weeks.

Pending in the same committee is the rivers and harbors bill that, as passed by the Senate, includes the provisions of the Johnson bill. The Senate has also passed the Johnson bill independently with an amendment authorizing, as a concession to Arizona, the construction of a dam at Head Gate Rock, fifteen miles south of Parker Dam, to divert water to the Colorado River Indian reservation. Both bills have been held up in the House Rules Committee because of objections from various members to one or another of the various PWA-financed dams.

Regulations For Works Projects Amended To Avoid Wage Inequalities

AN ORDER amending the rules and regulations governing security wages, hours of work and conditions of employment under the Emergency Relief Appropriation Act, to permit the ironing out of inequalities which have developed since the regulations were set up, was signed on July 29, by President Roosevelt. By the terms of this latest order the Works Progress Administrator, or his representative, may redefine regions set up in the original schedule where it is necessary to do so, in order to prevent different wage rates among workers accustomed to similar wages.

Wage schedules at Cincinnati, Ohio, and Newport, Ky., indicate the inequalities occasioned under the former rules. A bridge connects the two cities making Newport a part of the Cincinnati industrial area, and industrial wages have been uniform throughout the area. In the original order, Ohio is placed in area No. 1 and Kentucky in area No. 3. Under it unskilled labor at the Cincinnati end of the bridge would receive $55 a month; and in Newport, $29, with like differentials for intermediate and skilled help.

The new order amends the regulations prescribed on May 20, 1935, by striking out the paragraph which provides that monthly earnings applicable to a city should apply to contiguous urban areas, even though such urban areas are not in the same county and that earnings applicable to the largest municipality in a county should apply also to the rest of the county except if local circumstances warrant a different rate.

The Works Progress Administrator was also allowed to adjust the rate for any class of work by not more than 10 per cent.

Areas may be redefined

According to the new regulations the Works Progress Administrator may redefine any of the regions whenever he finds that it is necessary to do so to avoid inequality among workers accustomed to similar wage rates. Monthly earnings applicable to an urban area within a county shall apply to contiguous urban areas in adjacent counties, and if the territory covered by the operation of any project involves the application of more than one schedule of earnings the schedule for any class of work on the project shall be the highest.

In order to adjust the rate to local conditions and to avoid inequality among workers in the same region the Administrator may adjust the rate of earnings for any class of work on any project by not more than 10 per cent.

Power Control Outlined In Bonneville Dam Bill

A bill, offered by Senators McNary and Steiwer of Oregon, concerning power developments at Bonneville Dam was introduced into the Senate on July 29, by the Senate Commerce Committee as the result of a request by President Roosevelt for immediate and favorable action on the measure.

The bill as drafted gives the Secretary of War and the Chief of Engineers authority to complete and operate the project and to develop electric power to the economic maximum of the plant. Surplus power thus produced is to be sold wholesale and authority is given to buy or build the necessary distribution systems. Condemnation of property and the right to contract for interconnecting lines are also authorized.

Determination of wholesale rates on a basis of cost plus amortization of the part of the cost of the project chargeable to power production is given to the Federal Power Commission as is the determination of an accounting system. The commission will also advise the Secretary of War as to the extent of the development and it will also void contracts if retail rates are excessive. Public agencies will be favored over private in allocating power.

The states of Oregon and Washington will each get 18¾ per cent of any excess revenue over the cost of amortization.

Sewerage District Created For Merrimack Valley

An act establishing a Merrimack Valley Sewerage District embracing 16 municipalities in the region, including the cities of Lowell, Lawrence, Haverhill, and Newburyport, has been signed by Gov. Curley of Massachusetts. The purpose of the act is to provide for comprehensive improvements in the collection, treatment and disposal of sewage and other waste material now polluting the Merrimack River. As first discussed before the legislature this year the plan embodied the creation of a Merrimack Valley Authority of broad powers in the development and control of stream flow, conservation, industrial activity, power production and sanitation, but the final bill eliminated all but the purification provisions.

The act authorizes the appointment by the governor of a board of five members. The board is authorized to appoint staff members including a chief engineer, with combined staff salaries not exceeding $10,000 per year. It may construct trunk sewers, pumping stations, intercepting sewers and treating plants subject to the approval of the state department of public health, and make contracts for construction, operation and maintenance. Unless by Jan. 1, 1936, the federal government allocates at least $10,000,000 to the project, the act becomes void. Operating and maintenance costs are to be met by the municipalities on the basis of population. In New England engineering circles regret was expressed that the act failed to include provision for cooperative action between Massachusetts and New Hampshire in the purification of the Merrimack, since this could have been done without any additional outlay in money and since both states contribute to the pollution of the river.

Reclamation Plans Coordinated With Land Use Policy

IN CARRYING OUT the policy of coordinating the program of reclamation and land utilization it is planned to spend within the coming year the greater part of the $100,000,000 earmarked for the Bureau of Reclamation. In addition, $34,000,000 will be spent for land utilization.

The Advisory Committee on Allotments has recommended to the President additional allocations totaling $98,830,000 for the program. Of this latter sum, $64,830,000 is to be spent by the Bureau of Reclamation; $22,000,000 by the Resettlement Administration and $12,000,000 by the Forest Service. As more than $34,000,000 had previously been allotted for reclamation work, the latest recommendation for allocation of $64,830,000 will, if approved, provide for expenditure of the entire sum intended for this work, within the next year. There are 31 projects in the reclamation program located in Arizona, California, Colorado, Idaho, Montana, New Mexico, Oregon, Wyoming, South Dakota, Utah and Washington.

10 to 1 ratio planned

The funds recommended for the Resettlement Administration and the Forest Service would be used to take land out of present production and develop it for other uses. The Resettlement Administration, which is charged with the land utilization and conservation program, has optioned a total of approximately 11,000,000 acres all over the country. Options on 3,500,000 of these acres have been accepted. The Resettlement Administration is now making examinations of 250 possible locations for land purchases to carry out the rest of the program.

The program of the Bureau of Reclamation will put 100,000 acres into cultivation

(Continued on p. 170)

RFC Purchases More PWA Bonds And Offers Aid in FHA Program

Cooperation of the Reconstruction Finance Corp. was enlisted this week to promote public works and residential construction. By taking off of PWA's hands securities purchased in previous financing of municipal works and railroad equipment, $250,000,000 becomes immediately available in loans to finance new projects which receive an outright grant of 45 per cent of their cost from the new relief works appropriation. Applications to PWA cover 2,130 projects costing $501,000,000.

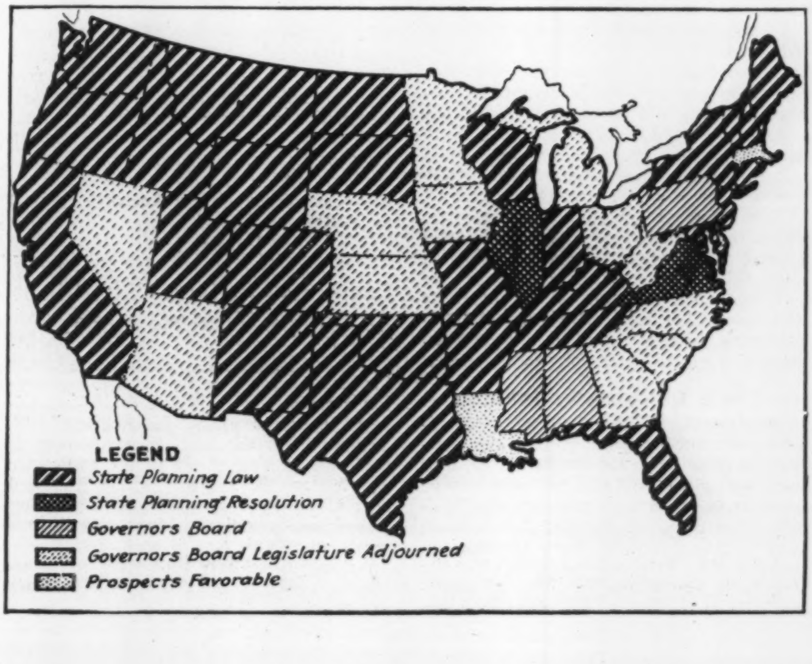
Large blocks on the municipal list include $41,681,000 worth of securities issued by the Sanitary District of Chicago, $9,500,000 in Triborough Bridge Authority securities, $8,000,000 worth of New York City securties, $5,000,000 in Los Angeles School District bonds and $3,600,000 in Cleveland municipals.

RFC aid to mortgage associations

To build up a broad market for FHA-insured home mortgages, Jesse Jones, RFC's chairman, has agreed that the newly organized RFC mortgage company will subscribe to stock in FHA-sponsored national mortgage associations matching dollar for dollar with private subscribers, to the extent of $10,000,000. By an amendment to the National Housing Act last May the capital stock required to organize a national mortgage association was reduced from $5,000,000 to $2,000,000.

Jesse Jones' offer will enable any group which can raise $1,000,000 to obtain another $1,000,000 from RFC and open its doors for dealing in FHA-insured home mortgages. Such associations are empowered to issue notes, bonds or other obligations to twelve times the par value of their stock. FHA has yet to announce formation of a national mortgage association but RFC's cooperation is expected to aid promotion. The RFC also will boost FHA's insured mortgage plan and, incidentally, promote residential construction by buying FHA-insured mortgages.

PRESENT STATUS OF STATE PLANNING IN THE 48 STATES


LEGEND
▨ State Planning Law
▦ State Planning Resolution
▨ Governors Board
▩ Governors Board Legislature Adjourned
▩ Prospects Favorable

Extension of Minimum Wage Regulations For Government Contracts Proposed

APPLYING the tremendous volume of government purchasing as a motivating force, the Walsh bill, reported favorably to the Senate, is designed as a lever to force "voluntary" adherence to the defunct NRA codes upon a large section of American industry. The Walsh bill is in the form of an amendment to the Bacon-Davis bill approved in 1931.

As now framed, the bill would give the President power to establish minimum wage and maximum hour standards, plus a 16-year age limit, applying to all contractors with the government, their subcontractors, and all persons furnishing articles, materials, supplies, equipment and services in connection therewith. These standards would apply not only to direct government transactions, but also to all operations financed in whole or in part by federal funds, loans or grants to political subdivisions, private corporations or individuals. Furthermore, the President would be empowered to require of contractors a pledge of adherence covering all their operations until June 30, 1937, or for the duration of performance of the contract.

Heavy penalties provided

Breach of these provisions would empower the contracting officer to withhold from payments due (1) double the amount of any wage deficiency, including overtime; (2) five times the amount of forced refunds or "kick-backs"; (3) $10 per day for every worker under 16 years. It would also subject the contract to cancellation and completion at the expense of the contractor or his surety, and his disqualification from bidding on other government work. Money withheld would be held by the Treasury subject to claims by underpaid workmen. A principal contractor may relieve himself of responsibility for persons not on his own payroll by requiring of subcontractors and material men certificates of compliance but must, in case of violation, cancel a subcontract when so directed or subject his own contract to cancellation.

Specific wage-hour standards would be determined by the President or his agent, taking into account (1) cost of living; (2) prevailing wages at the location of the job, both currently and as of 1934; (3) NRA code standards. The President could set an arbitrary rate for overtime, and could grant exceptions to the requirements of the act. He would also control how far back in the chain of equipment and material suppliers the compliance requirement would extend. Government agencies bidding in competition with private enterprise are specifically subjected to the requirements of the act. Provision is made for its application to existing contracts, with adjustment of compensation, where terms permit.

Early consideration expected

In view of the large amount of imminent government buying, which under present law must go to the lowest bidder, it is expected that the Walsh bill will receive early attention to protect government business from the chiselers. But it is believed that its effect will be more extensive in promise than in performance. Unless the Administration wishes to divide all industry into two classes—one depending entirely upon government business, the other refusing to touch it—the standards imposed cannot depart too much from commercial standards.

Ickes Denies Rumor Limiting Volume of Non-Federal Works

Administrator Ickes denied reports this week that any limit has been placed on the volume of PWA non-federal public works construction except the statutory allocation of $900,000,000.

"There has been no change in the President's attitude regarding public works," Ickes remarked. He also said that he had not heard of any intention to charge any part of the cost of PWA projects against the PWA allocation. He pointed out that, of course, it lies within the discretion of the President to raise or reduce the PWA allocation.

Army Engineers Get Funds For Conchas Dam

An allotment of $4,500,000 has been made to the Corps of Engineers from relief works funds for construction of Conchas dam on the South Canadian River in San Miguel County, N. Mex. Capt. Hans Kramer has been transferred from Memphis to Tucumcari, the headquarters of a new district. The project of which Capt. Kramer will have charge is designed to prevent flood losses and provide water for irrigation and for the city of Tucumcari.

The dam will be earth-filled, 26,600 feet in length and 230 feet high involving approximately 550,000 cubic yards of rock and earth excavation, 6,500,000 cubic yards of earth fill, 250,000 yards of riprap, and 70,000 cubic yards of plain and reinforced concrete. The dam will have a capacity of 800,000 acre feet and will submerge an area of 17,000 acres. The entire project calls for the expenditure of approximately $9,000,000. It will be located at the confluence of the Conchas and Canadian rivers, 28 miles northwest of Tucumcari. From this reservoir an irrigation canal will carry water to lands bordering the Canadian River. Included in the plans is the construction of a 30-in. pipe line from the reservoir supplying Amarillo as well as Tucumcari.

Engineers to Discuss Taxes At Camp Conference

The Fifth Annual Economic Conference for Engineers will be held at the engineering camp of Stevens Institute of Technology, Johnsonburg, N. J., August 10-18. Taxation and the cost of government is to be the general theme of the conference and among the subjects to be discussed are: Urban land valuation, state planning and financing cities through the depression.

Arrangements have been made for housing the conferees and recreational facilities are provided.

President Approves Allotment For Willamette River Survey

Among recent allotments approved by the President is the sum of $200,000 for a survey of flood control and power utilization possibilities in the Willamette River valley in Oregon.

The Willamette River, running north between the Cascade Mountain range and the Coast and emptying into the Columbia River near Portland, affects one of the most important agricultural and industrial sections in the state. The survey is planned to indicate the best method of stabilizing water resources. The counties directly concerned in the survey are Lane, Linn, Benton, Marion, Polk, Clackamas, Yamhill, Multnomah and Washington. Work can be started within fifteen days, and would be completed within sixteen months.

PWA Purchases West Side Site For Chicago Housing

Purchase of a 6½-acre site for the development of a low rent housing project on the west side of Chicago has been announced by the PWA Housing Division. Suspension of all work on the West Side project was ordered three months ago when investigation is said to have revealed organized attempts to force up land prices to a point which made low-rent housing impossible.

Plans call for the erection of a large city block of row houses and apartment buildings. The project will be named to honor Jane Addams, late founder of Hull House, who recommended its site. The area purchased by the government for development is bounded by Lytle, Sibley and Taylor Sts. and by Gilpin Place. PWA has made an allocation of $1,335,000 for the project. Before progress on the original West Side plan was impeded PWA had earmarked $12,500,000 to renovate completely one of Chicago's worst slum areas.

Plans for the amended project are now being completed in the hope of getting an early start on construction of the buildings. The site which was purchased is in the district which PWA originally sought to improve. The project is convenient to the West Side manufacturing district and within ten minutes from downtown Chicago.

The new buildings will all be of brick. Each unit will be provided with bath, refrigeration, electric lighting and gas. Central plants will provide steam heating. Row houses will be of four and five rooms and two stories in height; apartments will be of three stories containing three and four-room units. The project will include 1,068 rooms divided as follows: 183 three-room units; 91 four-room units; and 81 five-room units.

Bids asked on Montgomery project

Bids for the Bell Street project in Montgomery, Ala., will be received until August 27 by the PWA Housing Division. The Montgomery project is the first one for which bids have been invited under the recent ruling exempting PWA housing projects from the regulation that 90 per cent of the labor must be taken from relief rolls. This is the second PWA housing development to be allotted to Montgomery.

Bids for Fraser River Conduit Invited at Denver, Colo.

Bids for the construction of intake works at the Fraser River Dam and for dams at Jim Creek and Buck Creek are being invited by the city of Denver, Colo., and will be opened Aug. 8. Besides the intake work at the Fraser River Dam and at Jim Creek and Buck Creek, the items on which bids are being called are reinforced concrete spillway, transition and stilling basin for the Fraser River, Jim Creek and Ranch Creek conduits. The intake transition, spillway and siphon at the shaft, and unlined and lined canals for the Fraser River, Jim Creek and Ranch Creek conduits which are part of the Fraser River collection conduit, are also included.

The work on the dam calls for excavation of approximately 200,000 cu.yd. of stone and rock for the canal. About 1,700 cu.yd. of concrete and 175 lin.-ft. of precast concrete pipe are among the items for which bids will be received.

SOCIETY CALENDAR

PUBLIC WORKS ENGINEERING CONFERENCE, joint meeting of the American Society of Municipal Engineers and International Association of Public Works Officials, Cincinnati, Ohio, October 14-16.

INSTITUTE OF TRAFFIC ENGINEERS, sixth annual meeting at Louisville, Ky., October 15-16.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, annual convention, Miami, Fla., December 9-12.

AMERICAN WATER WORKS ASSOCIATION, Central States Division, Pittsburgh, Pa., August 22-24.

NEW ENGLAND WATER WORKS ASSOCIATION, fall convention, Providence, R. I., Sept. 17-20.

NEW ENGLAND AND NEW YORK STATE SEWAGE WORKS ASSOCIATIONS, joint meeting at Schenectady, N. Y., October 4-5.

EXAMINATIONS for registration of engineers will be held in the near future as follows:

IOWA—By Iowa State Board of Engineering Examiners at the State House, Des Moines, Sept. 4-5, 1935.

Charles West Named to Post Of Undersecretary of Interior

President Roosevelt's nomination of Charles West for the newly-created post of Undersecretary of the Interior was confirmed by the Senate on July 30. Mr. West, a former Congressman from Ohio, has been an instructor in government at Harvard, Tufts, and the College of Wooster, professor of political science at Denison University, and vice consul at Naples. He has recently been connected with the Farm Credit Administration, but acted as liaison officer between the White House and Congress.

Central States Floods Over Weather Bureau Forecasts

The flood season of 1935 is over in the river valleys of the central states, according to reports of the U. S. Weather Bureau. The Mississippi and its large tributaries will have no more floods according to past experience. The bureau has no record of an extensive flood in the Mississippi system between July 15 and winter. The outstanding feature of the floods in the central states this year, the worst since 1927, was the extremely rapid rise from the unusually low river levels left by the drought of 1934. In 1926 heavy rains saturated the ground, so that streams went into the winter well fed with water. More rain in late winter and spring fell on saturated ground making the 1927 floods inevitable. Conditions this year were different. At the close of winter streams were very low and the ground was extremely dry. However, the spring rains which broke the drought, were so hard and incessant as to pack the surface soil against rapid absorption. Rains ran off into creeks and rivers, flooding many of them.

The weather bureau issues flood warnings for very few of the rivers east and north of the Susquehanna. These rivers are too short and move too fast to make long forecasts possible.

Relief Works Funds Allotted For Los Angeles Flood Control

With an allotment of $13,869,000 from relief works funds, the Corps of Engineers will carry on the Los Angeles plan for flood control and water conservation on which local interests have already spent $55,000,000. The Los Angeles Flood Control District will contribute, in addition to rights-of-way, $3,500,000 toward the cost of fourteen related projects which will be undertaken by the Army engineers.

With design work for Fort Peck Dam, Montana, now practically completed, Capt. T. G. Wyman has been transferred to Los Angeles as district engineer to take charge of the program. Plans and specifications developed by the Flood Control District are in good shape and it is expected that the work will soon be ready for advertisement. Officers to assist Capt. Wyman at Los Angeles have not yet been selected.

Allotments under the present program are as follows:

Los Angeles—Channel construction and enlargement of a conduit, $1,545,000; two rock jetties extending into the ocean at the mouth of Ballona Creek, a riprap protected channel from the ocean to Inglewood Blvd., and a multibarrel concrete conduit from Washington Blvd. to Dunsmuir Avenue, $2,820,000; closing two gaps in the existing protection work along the lower Los Angeles river by riprap-lined levees, $555,000; reinforced concrete lined levees along the Los Angeles river, $1,592,000; reinforced concrete open channel throughout the length of Little Dalton Wash, $341,000; reinforced concrete conduit to carry storm waters from the city of Compton and southerly portions of Los Angeles to the Los Angeles River, $1,840,000; Kenter Canyon project, $594,000; reinforced concrete box conduit completing a trunk line system between Wilshire Blvd. and Ballona Creek, $289,000.

La Crescenta—Debris basins and reinforced concrete channels from the basins over existing cones to main stream, $1,492,000.

Alhambra — Reinforced concrete open channels in the Rubio Wash, $324,000. This work will complete improvements started on this stream and will increase the carrying capacity of the improvement reaches and prevent further destruction of property in the present gaps; for constructing reinforced concrete conduits in Alhambra Wash, in Mill Creek, and in San Pasqual Wash, $944,000.

Long Beach—Sump of 165 acre-ft. capacity and a pumping plant to discharge storm waters into Los Angeles river, $171,000.

Owensmouth — Training channel from Owensmouth Ave. to Havenhurst Ave., about seven miles, $187,000.

Pasadena — Debris basin just above North Ave. in Pasadena and a permanent channel from the basin to the Rio Hondo, $1,175,000.

ALL-WELDED BRIDGE IN NEW JERSEY INCLUDES 160-FT. SWING SPAN

The Riverside-Delanco bridge, in Burlington County, N. J., believed to be the longest all-welded truss bridge in the United States, has recently been completed across the Rancocas River. Made up of a 160-ft. swing span and two 112-ft. approach spans, the bridge has a total length of 397 ft. between back walls of the abutments. The roadway has a width of 36 ft. between curbs.

The design of the structural frame follows ordinary practice for small riveted bridges, with fillet-welding substituted for riveting at the connections. Except for a pair of riveted plate girders under the operating machinery at the center of the swing spans, the entire structure was fabricated by electric arc welding in the shop and in the field. Rolled sections are utilized for both chord and web members of the trusses. Connections are made with steel gusset plates and straps welded to the flanges of the intersecting members.

Washington Highlights

By Paul Wooton

Appointment of John Dickinson as assistant attorney general to have charge of anti-trust matters is seen as an indication that the Administration will try by administrative means to preserve as much as possible of the principle of NRA. Close observers are of the opinion that a liberal attitude will be assumed by the Department of Justice toward cooperation among business concerns that promotes fair trade practices and makes for the welfare of employees.

While President Roosevelt has expressed apprehension that the securities and exchange act may be unconstitutional under the interpretation which the Supreme Court has placed on interstate commerce, legal authorities are inclined to the belief that the principle of exchange regulation does not conflict with the fundamental law.

As the conferees argue over the many differences between the House and Senate banking bills, it is being emphasized that the really important phase of that situation is the securing of properly qualified men to be the governors of the Federal Reserve System. Much of the success of the new act, it is believed, will depend upon securing the services of broad gauge men, imbued with a determination to render the maximum of disinterested service, who will have the necessary banking experience and a grasp of practical economics.

Washington, July 30, 1935.

Arlington-Lowell Road Project Surveyed

The Massachusetts Department of Public Roads has announced the completion of a survey for a proposed motor highway of the 4-lane type to be built between Arlington, East Lexington and Lowell, a distance of about 17 miles. The construction cost is estimated at $3,662,000 and land damages at $369,000. The road is to connect with the Daniel Webster highway, a major route to the White Mountins.

Reclamation Plans

(Continued from p. 167)

within one or two years by buying and taking ten acres of land out of production for each acre that is put into cultivation through reclamation and irrigation projects. Specifically to offset these 100,000 acres, the Resettlement Administration and the Forest Service will buy 1,000,000 acres of land for retirement and conservation. Administrator Tugwell has been given $34,000,000 to take 1,000,000 acres out of cultivation, offsetting 100,000 that reclamation will bring in. The 10 to 1 ratio to be maintained in future is retroactive to the extent that it is planned to buy 4,000,000 acres to balance land developed by reclamation and irrigation during past few years.

CCC camps and relief workers will be placed on lands retired from cultivation in order to conserve and improve these lands. Much of the retired land will be used for public forests, national parks, improved ranges, wild life refuges and recreational areas.

Fort Peck Dam Work Gets New Allotment

An allotment of $6,000,000 requested by the Corps of Engineers for continuation of the work on Fort Peck dam and reservoir in Montana was approved by President Roosevelt on July 29. This is part of an application by the War Department for $21,000,000, of which $15,000,000 has already been granted. Gen. G. B. Pillsbury, acting Chief of Engineers, has pointed out that the progress of the work must be continued in order to avoid a considerable additional cost. The dam is of the earthfill type, and the closure must be made at a period of low water. Present plans call for completing the closure just after the high water of June, 1937. In order to accomplish this, the diversion tunnels must be completed at that time, otherwise a year's delay will be caused.

With the additional funds bids for completion of the tunnel linings and control shafts can be advertised at once. Plans have been completed and specifications are now being prepared.

The sum of $65,000,000 has previously been allotted for work on the project, and this allotment makes $71,000,000. To complete the project, it is estimated an additional $15,000,000 will be required. Funds previously allotted included $25,000,000 in 1933 from PWA funds; $25,000,000 in 1934 from PWA funds, and $15,000,000 this year out of FERA funds.

The Fort Peck reservoir is for flood control and navigation purposes on the Missouri River, and will furnish an 8 or 9-ft. navigation stage on the river below Sioux City.

Army Engineers Continue Work On Arkansas River Control

Repairs to Arkansas levees that were damaged or broken by the 1935 floods will be undertaken immediately under Section 7 of the Flood Control Act of May, 1928, providing for emergency repairs, while strengthening and rebuilding of levees will be sought under the WPA program, according to information from the Memphis, Tenn., district Army engineers. The district engineer's office has authority to advertise for bids and make emergency repairs under the 1928 Flood Control Act, but such work is limited to replacement of the original levee without improvements.

It is also reported that surveys are almost completed on a number of reservoirs, construction of which is proposed in the Wilson Flood Control bill, now pending in Congress, which will provide permanent flood control on the Arkansas River and its tributaries.

ENGINEERING NEWS-RECORD is a consolidation of Engineering News and Engineering Record, effected in 1917. The Contractor was consolidated with Engineering News-Record in 1918.
Engineering News was founded in 1874 by George H. Frost, as The Engineer and Surveyor, which title subsequently became The Engineer, Architect and Surveyor, then Engineering News and American Railway Journal and finally Engineering News, under the editorships of D. McN. Stauffer, A. M. Wellington and Charles Whiting Baker.
Engineering Record was established in 1877 by Henry C. Meyer as The Plumber and Sanitary Engineer. The name was subsequently changed to The Sanitary Engineer, Engineering and Building Record, and, finally, to Engineering Record. During his ownership of the paper Mr. Meyer was directly responsible for the editorial policy. John M. Goodell became editor of the paper in 1902 and was succeeded in 1913 by E. J. Mehren.
E. J. Mehren became editor of Engineering News-Record at the time of the consolidation in 1917, and was succeeded by Frank C. Wight in 1924. In July, 1928, F. E. Schmitt was appointed editor.

Brief News

DENVER, COLO., HAS A NEW BUILDING CODE in which contractors are divided into three classes. Unlimited general contractors are those doing jobs in excess of $15,000 and the annual license fee is $100. Limited general contractors are those doing general building work in amounts less than $15,000 and the annual license fee is $25. Special contractors are classed as those doing work on subcontracts, and the license fee is $10.

USE OF PWA MONEY for municipal electric plants in four Alabama cities has been temporarily restrained by an order granted July 25 by the District of Columbia Supreme Court. A hearing on the question has been set for August 1. The order, issued at the request of the Alabama Power Co., prevents Secretary Ickes from carrying out agreements allotting PWA funds to the cities of Decatur, Florence, Sheffield and Tuscumbia.

KNOXVILLE, TENN., WILL BALLOT in a few weeks on an issue of $1,000,000 worth of permanent improvement bonds for a school building, auditorium and armory.

Personals

GEORGE L. BUTTS, sanitary engineer in the Providence (R. I.) Department of Public Health since 1906, has tendered his resignation, effective Aug. 15.

WALTER F. SCHULZ, consultant engineer, Memphis, Tenn., has been chosen by the U. S. Department of State as a representative at the international congress at Brussels, Belgium, Sept. 2.

HARRY E. JORDAN, former president of the American Water Works Association and chemical engineer of the Indianapolis Water Co., has accepted membership on the national resources committee of the U. S. Chamber of Commerce.

EDWIN J. BENGLER, Cheshire; JAMES W. CONE, Greenwich; WILLIAM K. SIMPSON, Waterbury; CHARLES R. HOOVER, Middletown, and CHARLES F. SCOTT, New Haven, have been appointed as members of the Connecticut Board of Registration of Professional Engineers and Land Surveyors.

IRVING E. MOULTROP, chief engineer of the Edison Electric Illuminating Co. of Boston since 1926, retired from active service on Aug. 1. He was head of the construction bureau for many years, and was in charge of most of the plant development of the company.

J. W. JOURDAN has been appointed chief engineer of the Soil Conservation Service project in the Rio Grande watershed of New Mexico, north of Elephant Butte reservoir. For the past three years Mr. Jourdan has been assistant professor of civil engineering at the New Mexico State College, and prior to that was for nine years the designing hydraulic engineer for the San Joaquin Light and Power Corp., Fresno, Calif.

A. M. TORPEN, who served as construction engineer during the preliminary stages of Pickwick Landing Dam, has been transferred to the Knoxville, Tenn., office of the

TVA. He will be engaged in formulating general plans for unified control of stream flow for navigation, flood control, and power. Prior to his joining the TVA Mr. Torpen was engaged in making preliminary investigations of water resources and power sites in the U. S., Alaska, South America and Japan.

C. E. **Blee**, chief assistant engineer of the staff of the British Columbia Electric Railway Co., has left that position to become principal hydraulic engineer for the TVA at Knoxville, Tenn. Mr. Blee joined the engineering staff of the railway in 1911, and later was engaged on numerous projects in California and Oregon. In 1919 he was appointed assistant professor of civil engineering at Stanford University. After rejoining the staff of the Electric Railway Co. he took an important part in the design of major power projects for the company.

Obituary

Chester H. Norwood, construction engineer at Boston, Mass., for many years and at one time a member of the firm of Norwood & Ramsdell, contractors, died on July 27 at the age of 46.

Francis M. Andrews, superintendent of the Manchester (Mass.) water department from 1891 to 1922, died at his home in that town on July 23. He was born in Marblehead, Mass., 89 years ago, and in his early career was connected with the Salem (Mass.) water works and the Worthington Steam Pump Co. of New York.

John P. McGraw, who had been an engineer in the Queens (N. Y. City) Sewer Bureau until his retirement in 1934, died at his home in Richmond Hill, L. I., on July 25, at the age of 61. Mr. McGraw received his engineering education at Stevens Institute of Technology and had been in the service of New York City for 36 years at the time of his retirement.

Albert Carl Lehman, chairman of the board and founder of the original unit of the Blaw-Knox Co., died July 24th at his residence in Pittsburgh, Pa. He was 57 years old. Mr. Lehman was prominent in the steel industry as the head of the Blaw-Knox Co., which he was largely instrumental in building from a small manufacturing unit to a large concern. He served the company first as vice president, and later as president, continuing in this capacity until recently when he was elected as chairman of the board. Mr. Lehman was also a director of many other manufacturing and financial institutions. Mr. Lehman, who graduated from Harvard in 1897, was also a member of the Engineers Society of Western Pennsylvania.

CONSTRUCTION STATISTICS FOR THE WEEK

ENGINEERING construction awards for this week total $21,054,000 compared with $25,924,000 a week ago and $19,825,000 a year ago. This week's total is made up of private, $7,477,000 and public, $13,577,000 of which $3,608,000 is federal and $9,969,000 state and municipal. Corresponding totals last week were: private, $5,596,000; public, $20,328,000; federal, $6,262,000 and state and municipal, $14,066,000. Last year the volume of the corresponding week was classified: private, $2,153,000; public, $17,672,000; federal, $2,668,000; and state and municipal, $15,004,000.

Highway awards continue to climb slowly and this week reached $5,246,000 compared with $4,818,000 last week. Public buildings are somewhat higher than last week and earthwork, irrigation, drainage and waterways considerably lower. All other classes of work remain about the same.

The larger projects for the week include: Wyandotte High School, Kansas City, Kans., $1,694,000; highway awards by Texas, $444,000, by Wyoming, $548,000, and by Utah, $413,000. New York, Chesapeake and St. Louis R. R. awarded bridge at New York-Pennsylvania line, $500,000. At Woodriver, Ill., the relief and trunk sewer project was let at $436,000. U. S. Corps of Engineers let the dredging in Tampa Harbor, Fla., for $1,316,000; at Seattle, Wash., federal contract was let for rebuilding part of South Jetty at Gray's Harbor, $359,000; and at Agawam, Mass., the Agawam Racing and Breeders Assn. race track, grandstand and clubhouse at Bowles Airport was let for $750,000.

New capital continues to gain volume due to approvals for PWA and WPA allotments which are coming through in heavier volume. State and municipal bond sales were low this week.

CONTRACTS

(Thousands of Dollars)

	Weekly August 1934	Average Prev.4 Weeks	Week Aug.1 1935
Federal Government	$6,382	$3,826	$3,608
State and municipal	11,400	12,285	9,969
Total public	$17,782	$16,111	$13,577
Total private	4,041	5,607	7,477
Week's total	$21,823	$21,718	$21,054

Cumulative to date:
1934...$850,799,000 1935...$765,198,000

NEW PRODUCTIVE CAPITAL

(Thousands of Dollars)

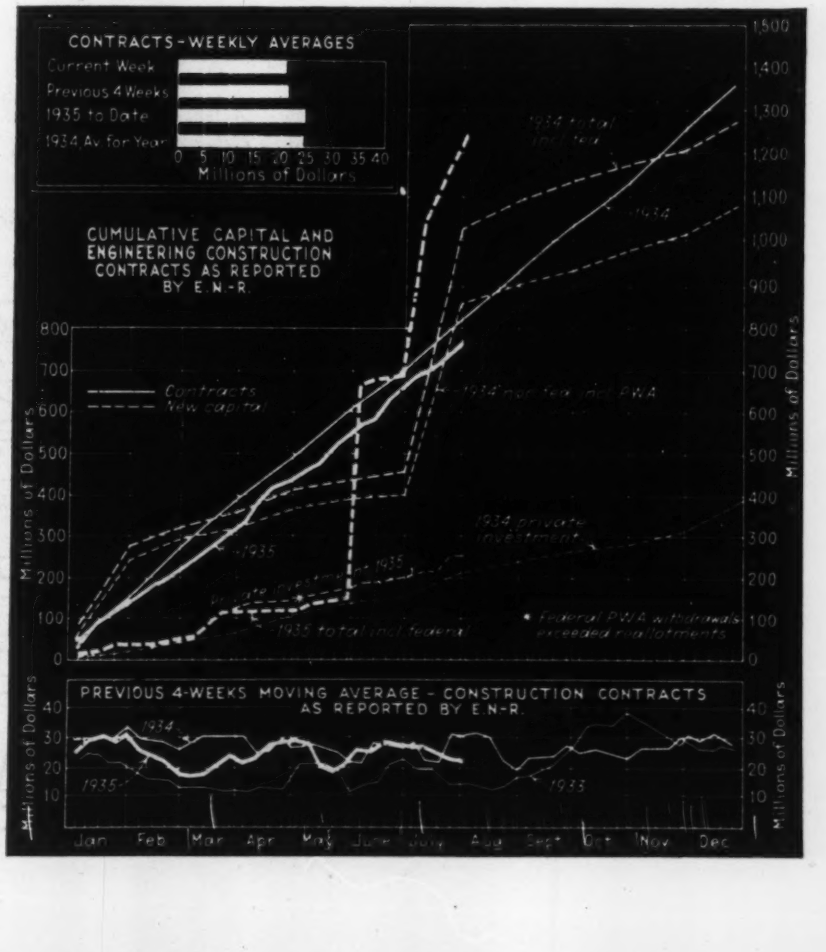
1935	Week Aug. 1	Cumulative
State and municipal...	$733	$252,074
PWA allotments, S&M	39,956	246,041
RFC loans, S&M......	......	36,084
Corporate issues	......	18,124
PWA private	......	8,629
Local contrib. to WPA	756	1,037
Total, non-federal...	$41,445	$561,989
PWA federal	16,731	685,739
Total new capital...	$58,176	$1,247,728

Cumulative to date:
1934..$1,052,598,000 1935..$1,247,728,000

Note: These figures include private bonds, and stocks sold for productive purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities, including the special highway funds; PWA private loans, and allotments for Federal construction. An arbitrary percentage (25%) of the WPA allotments and local contributions to WPA work is included to allow for the capital additions through the Works Progress Administration division of the new program.

INDEX NUMBER

ENR Cost	1913 = 100	1926 = 100	ENR Volume	1913 = 100	1926 = 100
Aug., 1935..	**195.10**	**93.82**	**July, 1935...**	**96**	**42**
July, 1935...	195.18	93.82	June, 1935...	122	54
Aug., 1934...	198.40	95.37	July, 1934....	128	56
1934(Av.)...	198.10	95.23	1934(Av.)...	114	50
1933(Av.)...	170.18	81.80	1933(Av.)...	102	47
1932(Av.)...	156.97	75.45	1932(Av.)...	127	56



BUSINESS SIDE OF CONSTRUCTION

July Construction Awards Lower Both Private and Public Down

ENGINEERING construction awards for July total $86,873,000, the second lowest month this year. This volume compares with $110,161,000 last month and $118,000,000 last year. Private awards dropped from $38,700,000 in June to $22,430,000 in July and public works from $71,461,000 to $64,443,000. Comparable figures a year ago are: private, $17,839,000 and public works, $100,161,000. July awards this year thus represent an increase over last year in private construction and a decrease in public work.

Geographically, Middle Atlantic territory is running well ahead of last year, Middle West and West of Mississippi awards for July were substantially the same as last year, while South, New England and Far West dropped below a year ago. In July New England, Middle Atlantic, South and Middle West dropped below the June volume while West of Mississippi and Far West awards increased.

Highway awards increased over the June volume but continued to run lower than a year ago. Awards from the new funds have not yet started in sufficient volume to affect the statistics. Building awards dropped off in July, particularly in the public and industrial groups while commercial buildings almost held the higher rate established in June. Commercial building awards are more than double the volume of last July while both public buildings and industrial buildings dropped below a year ago.

New Capital

The new capital curve continued sharply up in July with both public and private financing contributing to the high volume. The total volume for the month is $467,057,000. State and municipal bond sales totalled $53,751,000 for the month; RFC loaned $36,000,000 to the Metropolitan Water District of Southern California; $125,000,000 to the states for highways became available under the Hayden-Cartwright Act; and $113,408,000 in federal loan and grants from PWA funds was approved. Private corporate financing totalled $980,000 and PWA loans to corporations, $570,000. Financing of federal work totalled $137,067,000 including an arbitrary percentage (25%) of Works Progress Administration allotments for work relief projects. A similar proportion of the local contributions to WPA projects approved adds $281,000 to the new capital reported for July.

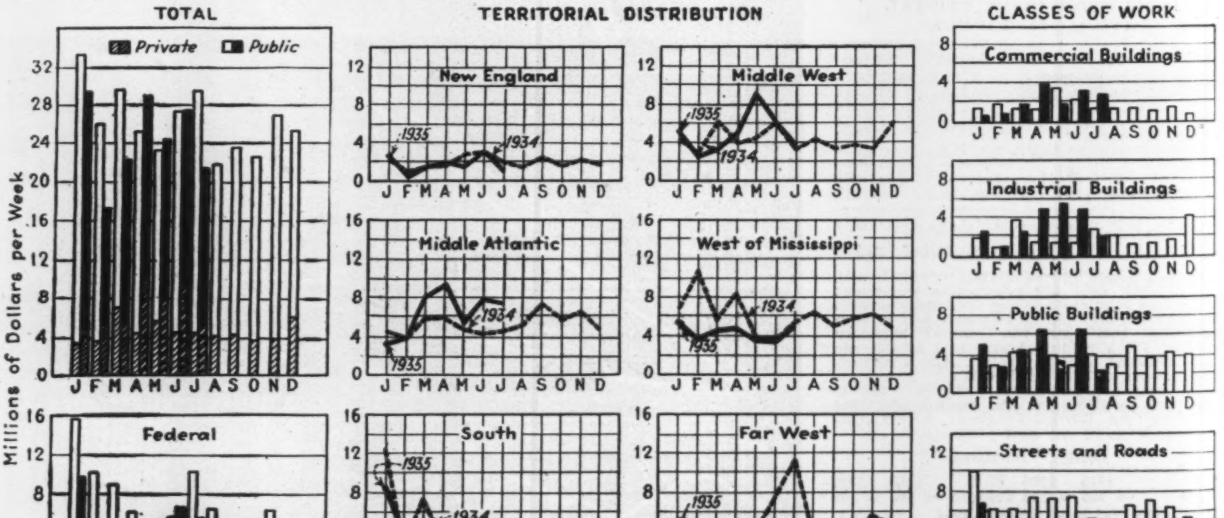
ENGINEERING CONSTRUCTION CONTRACTS REPORTED IN JULY, 1935

Four Weeks—Thousands of Dollars—(000 Omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States July 1935	United States Seven Months 1935	United States Seven Months 1934	Canada
Public Works										
Waterworks	38	368	137	264	581	333	**1,721**	37,282	44,118	507
Sewerage	369	1,655	25	416	878	3,289	**6,632**	40,080	32,853	105
Bridges, public	254	2,326	280	720	542	983	**5,105**	39,757	54,897	42
Earthwork and waterways	120	4,295	302	5,715	8,229	1,441	**20,102**	106,444	185,480	1,756
Streets and roads	880	3,171	2,666	2,460	4,792	2,160	**16,134**	144,749	212,923	510
Buildings, public	368	3,809	311	778	2,290	1,510	**9,121**	132,537	115,775	310
Unclassified, public	122	3,500	211	295	1,138	362	**5,628**	31,998	39,231	52
Total public	2,156	19,124	3,987	10,648	18,450	10,078	**64,443**	532,847	685,277	3,282
Federal gov't (included in above classifications)	79	533	806	6,012	9,361	1,821	**18,612**	156,306	251,363	49
Private										
Bridges, private	.....	246	17	49	50	......	**362**	8,218	7,018	.....
Buildings, industrial	1,255	2,111	533	2,011	921	1,047	**7,878**	99,044	58,752	1,178
Buildings, commercial	405	8,161	352	1,290	105	1,237	**11,550**	62,412	53,728	880
Unclassified, private	105	276	110	439	1,374	336	**2,640**	41,623	26,199	91
Total private	1,765	10,794	1,012	3,789	2,450	2,620	**22,430**	211,297	145,697	2,149
July 1935 (4 weeks)	**3,921**	**29,918**	**4,999**	**14,437**	**20,900**	**12,698**	**86,873**	......	......	**5,432**
June 1935 (4 weeks)	12,234	31,903	14,782	24,556	14,719	11,967	110,161	......	......	10,722
July 1934 (4 weeks)	7,826	17,730	13,019	12,940	21,309	45,176	118,000	......	......	1,940
Seven months, 1935	50,296	191,827	114,985	152,342	132,978	101,716	......	744,144	......	39,182
Seven months, 1934	59,776	145,203	154,308	136,576	186,610	148,501	......	......	830,974	24,097

ENGINEERING CONSTRUCTION REPORTED BY E.N.-R.-WEEKLY AVERAGES

□---1934 ■—1935



Building Permits

Building permit values in June established a new peak since November, 1931, according to Dun & Bradstreet, Inc. Reports from 215 cities of the United States show a total estimated cost of permits issued last month amounting to $52,702,353, against $49,327,248 for May, or a gain of 6.8 per cent. The June total represents an increase of 84.1 over the same month of last year when permits equalled $28,621,565.

The value of building construction in June, according to reports received by the Bureau of Labor Statistics, shows an increase of more than 10 per cent over May. Indicated expenditures for new residential buildings and non-residential buildings showed pronounced gains. The estimated cost of additions, alterations, and repairs to existing buildings, however, was somewhat less than in the previous month. Comparing the two months there was a decrease of 11 per cent in the number of buildings for which permits were issued.

Compared with June of last year the estimated cost of all buildings for which permits were issued shows an increase of almost 90 per cent. Indicated expenditures for residential buildings were more than three times as great as in June, 1934. Increases in the value of residential buildings in each of the nine geographic divisions amounted to over 100 per cent. The value of new non-residential buildings increased 75 per cent, and the value of additions, alterations, and repairs shows an increase of more than 22 per cent. These comparisons are based on building permit reports received by the Bureau of Labor Statistics of the United States Department of Labor from 784 identical cities having a population of 10,000 or over.

Materials

Cement—Shipments of Portland cement in June totalled 7,624,000 bbl., a decrease of 10.7 per cent compared with June last year. Stocks at mills were 6.9 per cent higher than a year ago according to reports received by the Bureau of Mines.

For the first 6 months Portland cement shipments totalled 31,926,000 bbl. compared with 35,165,000 bbl. shipped in the same period of 1934, a decrease of 9.2 per cent. This corresponds fairly closely with the decrease of 8 per cent in engineering construction awards reported by *Engineering News-Record* for the same period.

The ratio of production to capacity was 39.6 for June, 1935, compared with 36.1 in May and 39.8 in June last year.

Steel—The operating rate of steel companies having 98.7 per cent of the steel capacity of the industry increased during July from 32.8 per cent for the week beginning July 1 to 44.0 per cent for the week beginning July 29 according to reports by the American Iron and Steel Institute. The average rate for the five weeks is 38.8 compared with similar 5-week averages, one week ago 37.6, one month ago 37.5, and one year ago 26.6.

Lumber—Lumber production during the week ended July 20 was the heaviest of any week to date of 1935 except one; shipments and new orders continued their upward trend and were highest since May. Shipments were 8 per cent below output; new business was 11 per cent below. Total production of reporting mills was 36 per cent above corresponding week of last year; shipments were 56 per cent and new business 45 per cent heavier than during the 1934 week. However, many small mills, active last year, are idle this year or are operating intermittently. These comparisons are based upon reports to the National Lumber Manufacturers Association from regional associations covering the operations of 630 leading hardwood and softwood mills. During the week ended July 20 these produced 191,969,000 feet; shipped 177,342,000 feet; booked orders of 170,484,000 feet. Revised figures for the four preceding weeks average as follows: shipments 162,324,000 and orders 155,700,000 feet.

Prices

Price changes are not numerous and those reported are scattered both geographically and by products. Cement dropped 4c. in Cleveland, ready mixed concrete increased $1.10 in Cleveland and dropped 25c. in Minneapolis. Gravel prices are down 5c. and sand 10c. in New York. In Cleveland structural clay tile takes a big drop, from $62.50 to $45.00 on the 3x12x12 partition tile and corresponding decreases in other sizes except the 10- and 12-in. load bearing. Common lime increased in Baltimore and decreased in Cleveland and Boston, while hydrated finishing lime also decreased in the two latter centers. Lumber prices increased in Dallas but are lower in Denver.

Labor

Employment in the production of six major construction materials increased in June to 44.8 on the unadjusted index from 43.1 in May and 44.4 a year ago, according to report of the Federal Employment Stabilization Office.

An early report from the Bureau of Labor Statistics indicates that employment in the private building construction industry increased 11.2 per cent and payrolls, 15.3 per cent in May compared with April. These gains exceed the increases reported in May in any of the four preceding years for which data are available. This statement is based on reports from 10,274 contractors employing 84,692 workers employed in private building projects not aided by PWA funds.

Employment by the construction industry in New York State advanced only 1.1 per cent from May to June according to reports from 1,300 contractors to the New York State Department of Labor, Division of Statistics and Information. The increase in highway construction employment amounted to 19 per cent.

Beginning July 1, public works contractors in California began employing labor on a 40-hr. basis when the 1935 emergency 30-hr. law automatically expired.

On the Works Progress Administration work a signed order establishes a maximum of 8 hours in any one day and 70 hours in any semi-monthly period covered by payroll checks. Both daily and semi-monthly hours of work may be exceeded in the case of an emergency involving the public welfare or the protection of work already done on a project and in exceptional or unusual circumstances.

Labor controversies settled include the Boulder Dam strike, on which approximately 800 workmen were out two weeks, asking $1 an hour for skilled trades and 75c. for unskilled, and a 7½-hr. day with lunch on the Company's time. The strike ended July 26 when the wage controversy was referred to the PWA Administrator with a request for a new allotment to provide for increased wages.

The electricians, striking on the $1,250,000 improvement job on the Interior Building in Washington, D. C., returned after 9 days when the Government agreed to postpone repairs on which non-union labor was employed.

ENR Cost and Volume Index

THE *Engineering News-Record* Construction Cost Index is 195.10 for August, due to a slight drop in the common labor wage average. The *ENR* Volume Index for July is 96 compared with 122 a month ago and 128 last year.

INDEX NUMBER

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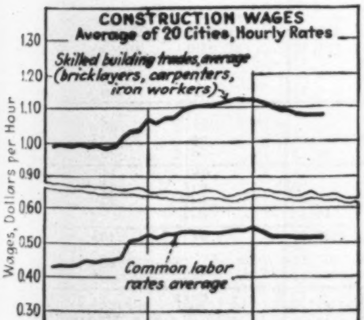

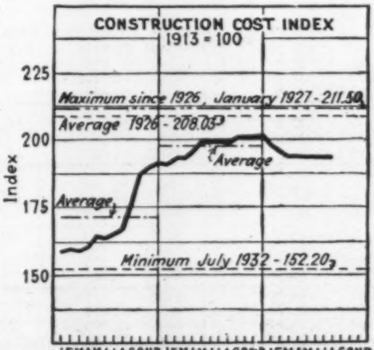

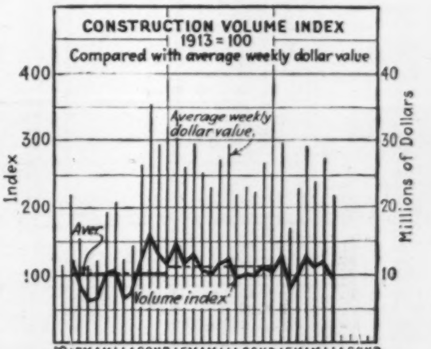

CURRENT PRICES OF CONSTRUCTION MATERIALS

CEMENT, AGGREGATES AND READY-MIXED CONCRETE—F.O.B. CITY

	PORTLAND CEMENT Per bbl., carload lots, including 40c. per bbl. for bags, cash discount not included			SAND AND GRAVEL Per ton, carload lots			CRUSHED STONE Per ton, carload lots		CRUSHED SLAG Per ton, carload lots, f.o.b. plant		CONCRETE Ready Mixed 1:2:4, 50c.y. or more, delivered
	Cloth Bags*	Paper Bags	Bulk	Gravel, 1½ in.	Gravel, ¾ in.	Sand	1½ in.	¾ in.	1½ in.	¾ in.	
Atlanta	$2.89	$2.64	$2.44	$2.31	$2.31	$1.64	$1.69	$1.92	$1.80	$1.80	$8.25
Baltimore	2.69	2.44	2.24	1.80‡	1.80‡	1.30‡	1.80‡	1.80‡	2.25	2.25	7.35
Birmingham	2.55	2.30	2.10	1.75	1.75	1.40	.85	.85	.90	1.15	5.45
Boston	2.72	2.47	2.27	1.50	1.50	1.10	1.50	1.50	.....	.....	7.00
Chicago	2.85‡	2.60‡	2.40	2.60‡	2.60‡	2.05‡	2.60‡	2.60‡	.....	.....	.....
Cincinnati	2.60	2.35	2.15	1.20	1.20	1.10	1.80	1.80	.....	.....	6.70
Cleveland	2.41	2.16	.....	1.55	1.55	1.45	1.60	1.60	1.75	1.75	8.85
Dallas	2.45	2.20	2.00	1.55	1.55	1.30	2.10	2.25	.....	.....	7.00
Denver	3.09	2.84	.....	1.85	.....	1.25	.....	.....	.....	.....	.....
Detroit	2.26	2.01	1.81	1.30	1.30	1.20	1.40	1.60	1.40‡	1.50‡	6.75
Kansas City	2.50	2.25	2.05	.....	1.85	1.15	1.85	1.40-1.55	.....	.....	7.65
Los Angeles	2.70	2.42	.....	1.60	1.60	1.20	1.60	1.60	.....	.....	6.70‡
Minneapolis	2.90	.....	2.45	1.00[p]	1.00[p]	.25[p]	1.00[p]	1.00 [p]	.....	.....	5.75
Montreal	.....	1.70	.....	.85	.90	1.25	1.25	1.60	.....	.....	6.00
New Orleans	2.40	2.22	2.00	1.75	1.75	1.45	.....	.....	.....	.....	8.25
New York	2.60‡	2.35‡	.....	1.25†[h]	1.25†[h]	.75†[h]	1.75†[h]	1.85†[h]	.....	.....	7.60
Philadelphia	2.63	2.38	2.18	1.80‡	1.90‡	1.50‡	2.60‡	2.75‡	1.00‡	1.00‡	7.75
Pittsburgh	2.46	2.21	1.61	1.50‡	1.50‡	1.70‡	2.25‡	2.25‡	1.50	1.50	7.00
St. Louis	2.53	2.28	.....	1.00‡	1.00‡	1.00	.75$_p$	.75$_p$	.65/.95§A	.50/.95§B	6.65
San Francisco	2.72	2.52	2.20	1.35	1.35	1.35	1.50	1.50	.....	.....	7.53
Seattle	3.09	2.84	.....	1.00	1.00	1.00	1.44	1.44	.....	.....	7.56

*10c. allowed for each returnable bag. †Per cu. yd. ‡Delivered. §F.o.b. Granite City, Ill. A Above 5/16" size, B 5/16" and below—new code sizes. [h]Barge lots alongside dock. [p]f.o.b. plant. $_p$5 tons or more.

CURRENT MAXIMUM NET PRICES RECEIVED AT CEMENT MILL

Charge for bags not included. For cloth bags, add 40c. per bbl.; 10c. refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refundable.

	Bagged	Bulk		Bagged	Bulk		Bagged	Bulk
Alpena, Mich	$1.50	$1.45	Ironton, Ohio	$1.60	$1.55	North Birmingham, Ala	$1.75	$1.70
Buffington, Ind	1.70	1.65	Iola, Kans	1.70	1.65	Richard City, Tenn	2.00	1.95
Crestmore, Calif	1.72	....	La Salle, Ill	1.60	1.55	Saginaw, Mich	1.50	1.45
Dallas, Tex. (Inc. 5c. tax)	1.80	1.75	Limedale, Ind	1.70	1.65	Steelton, Minn	1.80	1.75
Hannibal, Mo	1.70	1.65	Mason City, Ia	1.70	1.65	Universal, Pa	1.65	1.60
Hudson, N. Y	1.75	1.70	Norfolk, Va	1.76	1.71	Waco, Tex. (Inc. 5c. Tax)	1.80	1.75
Independence, Kans	1.70	1.65	Northampton, Pa	1.65	1.60	Wyandotte, Mich	1.45	1.40

Cash Discounts, Cement, to Contractors: truck delivery, 2% for cash on 10th of month; on carload deliveries, no trucking, same as dealer cash discount, 10c. per bbl. for payment within 15 days of date of invoice.

STRUCTURAL CLAY BUILDING TILE, BRICK AND LIME—DELIVERED

	STRUCTURAL CLAY TILE—PARTITION—SCORED Per M, lots of 2,000 pieces or over,			STRUCTURAL CLAY TILE—LOAD BEARING—SCORED Per M, lots of 2,000 pieces or over,			BRICK Per M, in quantity,		LIME Per ton, in paper, carload lot,		
	3x12x12 in.	4x12x12 in.	8x12x12 in.	8x12x12 in.	10x12x12 in.	12x12x12 in.	Common backing	Straight hard	Hydrated finishing	Common hydrated	Pulverized or lump
Atlanta	$75.80	$80.80	$151.60	$181.90	$212.20	$242.50	$14.25	$14.25	$24.00	$17.00	$15.90
Baltimore	91.00	98.00	183.00	219.00	315.00	390.00	13.00	17.00	17.00	12.50	19.25
Birmingham	78.75	84.00	157.50	189.00	201.25	242.00	15.00	22.50	3.00§	1.75§	2.25§[e]
Boston	72.50s	77.45s	145.35s	164.50s	203.70s	......	14.50	18.00	17.50	12.50	3.10$_g$[e]
Chicago	66.00	70.40	132.00	......	......	......	10.20	11.20	18.00	13.40	14.00
Cincinnati	70.45	74.95	140.50	168.65	210.00	260.00	17.50	17.50	15.97	12.48	.....
Cleveland	45.00	48.00	90.00	108.00	188.00	214.75	16.50	16.50	16.00k	14.00k	2.65k$_p$
Dallas	72.00	75.00	197.00	177.00	217.00	269.00	13.50	26.00	21.20	14.50	1.70 $_p$
Denver	78.50	88.00	141.50	166.50	196.00	225.00	10.00–15.50	21.00–30.00	25.00	17.00	20.00
Detroit	71.85	76.65	143.70	230.00	280.00	325.00	11.50	12.50	14.25	11.90	22.00
Kansas City	72.50	72.50	92.00*	140.50	177.75	207.25	15.00	24.00	15.00	11.25	14.00[e]
Los Angeles	77.50	94.25	134.00*	188.00	232.50	311.50	11.50	14.00	18.70	.....	19.70
Minneapolis	80.15s	85.50s	145.40s	167.75s	175.25s	243.70s	13.10	15.10x	25.50	21.00	23.00
Montreal	79.10s	90.40	169.50s	......	212.40	136.60	20.75	31.00	23.00	11.00	.....
New Orleans	61.60	65.10	123.20	158.90	196.70	......	14.00	.....	16.75	13.05	.....
New York	84.00	90.00	135.00*	193.30†	238.80†	295.60†	10.50	.....	20.80	16.00	20.80
Philadelphia	76.00	80.00	150.00	172.00	240.00	295.00	18.00	20.00	16.35	11.25	10.75
Pittsburgh	58.40c	62.30c	116.85c	165.00c	217.00c	250.00c	17.50	22.00	17.20	14.50	2.22$_p$
St. Louis	62.00	65.00	120.00	165.00	187.00	214.00	15.00	18.00	.48‡	.38‡	2.80$_p$
San Francisco	84.00	94.50	225.00	......	......	......	15.00	18.00	22.50	21.50	2.05$_p$
Seattle	86.00	94.50	210.00	198.00	198.00	198.00	15.00[d]	18.50	30.00	26.00	3.00$_p$

*6x12x12 in. †F.o.b. Perth Amboy, N. J. ‡Per sack. §Per bbl., 200 lbs. $_p$Per bbl. 180 lbs. $_g$per bbl. 280-lb. kLCL. [d]less $1 cash 15 days. [e]lump. $_s$Smooth. x Selected common.

ROAD SURFACING MATERIALS—F.O.B. CITY

	PAVING BRICK AND BLOCKS			PAVING ASPHALT Per ton, less than 80 penetration,		ASPHALT BINDERS—FLUXES Per gal., 80-300 penetration,		CUTBACK ASPHALT Per ton,		ROAD OILS Per gal.,	ASPHALT EMULSION Per gal.,	
	Granite per M, lots of 50,000, 4x4x8 in.,	Brick per M. 3x8½x4 in., carload lots	Wood per sq.yd., 3½ in., 16-lb. treat,	Tank car	Drums	Tank car	Drums	Tank car	Drums	Tank car	Tank car	Drum
Atlanta	$ 75.00	$35.00	$2.25	$17.40[2]	$22.57[2]	$0.0644[2]	$0.911[2]	$15.90[2]	$23.82[2]	$0.0586[2]	$0.085	$0.085
Baltimore	110.00	44.00	2.35	17.00	22.00	.07	.095	.085†	.12†	.....	.....	.....
Birmingham	110.00	24.00	....	18.00	23.00	0.778	.1028	.082†	.112†	.....	.06	.....
Boston	78.00	30.00	2.50	16.00	21.00	16.50#	21.50#	.09†	.12†	.075	.09	.125
Chicago	125.00	42.00	2.60	.....	.....	....	.....	.....	.....	.....	.....	.....
Cincinnati	115.00	37.00	....	18.00	22.00	.09	.....	18.50	.....	.07	.08	.....
Cleveland	100.00‡	32.75	2.85	20.00	24.50	.075	.09	.075†	.049†	.06	.085	.10
Dallas	.....	30.00	....	16.10	21.10	.0525	.10	15.65	23.15	.055	.1076	.1438
Detroit	.....	37.00	....	19.67[a]	24.87[a]	.....	.....	17.00	22.50	.055	.11	.15
Kansas City	.....	45.00	....	18.50	23.50	17.50#	22.50#	.077†	.107†	.057	.11	.15
Los Angeles	.....	50.00	....	10.34	14.50	10.34#	14.50#	10.34	.....	.042	.06	.12
Minneapolis	.....	.....	2.50	18.20	24.70	.098	.098	21.85	34.65	.048	.....	.....
Montreal	70.00	100.00	....	14.00	19.66	.07	.093	19.00	26.50	.07	.125	.155
New Orleans	100.00	32.00	....	14.50	18.50	.065	.09	.07†	.10†	.....	.....	.....
New York	130.00§	50.00	2.64	17.00	22.00	.07	.095	.085†	.12†	.....	.075	.11
Philadelphia	122.00	45.00	2.25	13.50	18.00	.05	.08	.05†	.08†	.045	.08	.....
Pittsburgh	115.00	40.00	....	19.00	24.00	.0775	.1125	.086†	.121†	.0675	.....	.....
St. Louis	115.00	35.00	2.00	19.70	24.70	.075	.075	.875†	11.75†	.04	.09	.125
San Francisco	.....	50.00	....	12.00	18.00	12.00#	18.00#	12.50#	23.00#	.04	.0575	.117
Seattle	.....	55.00	....	25.50	25.50	17.00#	23.00#	15.00	.....	.03	.19	.20

Note: Paving asphalt, tank car or boat, f.o.b. Maurer, N. J., per ton, Bermudez, $25.00; Trinidad, $21.00. *Per sq. yd. †Per gallon. ‡4½x6x5½in. #Per ton §4x5x9-in. Av. [a]Mexican. [2]local reduction due to 20% reduction intra-state class freight rates, only Georgia affected.

CURRENT PRICES OF CONSTRUCTION MATERIALS

IRON AND STEEL PRODUCTS—BASE MILL PRICES

	STRUCT. SHAPES-PLATE	REINF. BARS ⅝-in. billet,	RIVETS ¾-in. structural	WIRE NAILS Base	SHEET PILING Base	STEEL RAILS Per Gross Ton Standard	Light	Re-rolled	TRACK SUPPLIES Angle bars	Std. spikes	Tie plates	Track bolts
Birmingham...	$1.95	$2.10	.....	.....	.....	$36.375	$34.375	$35.00	$2.55	$2.40	$1.90	$3.55
Chicago........	1.85	2.10	$3.00	.....	$2.25	36.375	35.00	34.00	2.55	2.40	1.90	3.55
Pittsburgh.....	1.80	2.05	2.90	$2.60	2.15	36.375	35.00	34.00	2.55	2.40	1.90	3.55

IRON AND STEEL PRODUCTS—BASE MILL PRICES, PER 100 LB., CARLOAD LOTS

F.O.B. WAREHOUSE	STRUCTURAL SHAPES Per 100 lb., base price	REINFORCING BARS Per 100 lb., ⅝ in., base price New billet	Rail steel	EXPANDED METAL LATH Per 100 sq.yd., carload lots Std. diamond mesh, 3.4 lb.	Std. ribbed 3.4 lb.	WELDED FABRIC REINFORCING Per 100 s.f., carload lots 4x16 in., No. 5 & 10 wires	4x12 in., No. 8 & 12 wires	6x6 in., No. 6 & 6 wires Per sq.yd.	SHEET PILING Per 100 lb., base price
Atlanta.............	$3.36	$2.34	$2.19	$21.00	$23.00	$1.53	$1.16	$0.1449	$2.70
Baltimore............	3.00	2.75	2.60	25.00	28.00	1.41	1.08	.1332	2.90
Boston............	3.54	3.18	2.25	21.50†	23.50†	1.46	1.12	.1449	2.30
Chicago............	3.20	2.10	1.95	22.00	26.00	1.40	1.08	.1323	2.25
Cincinnati............	3.40	3.25	3.25	25.01	29.50	1.39	1.07	.1287	....
Cleveland............	3.16	2.60	2.45	20.00	22.00	1.37	1.06	.1287	....
Dallas............	2.65	2.495	2.345	22.00	25.00	1.63	1.23	.1548	2.985
Denver............	3.89	3.67	3.52	22.00	25.00	1.68	1.26	.1548	....
Detroit............	3.17	2.20	2.05	20.00†	22.00†	1.41	1.08	.1323	2.43
Kansas City............	3.74	2.74	2.59	19.00	21.00	1.50	1.14	.1422	2.69
Los Angeles............	3.10	2.45	....	23.00	27.50	1.68	1.26	.1584	2.65
Minneapolis............	3.45	2.86	2.71	22.00	26.00	1.51	1.15	.1431	2.55§
Montreal............	2.90	3.00	2.80	.....	.....	2.30	1.71	.238	2.65
New Orleans............	....	....	....	19.15	23.00	1.54	1.17	.1458	....
New York............	3.37	2.86	2.71	20.00	22.00	1.44	1.11	.1359	2.48
Philadelphia............	2.98	3.06	2.22	20.00	24.00	1.42	1.09	.1332	2.46
Pittsburgh............	1.80‡	1.80‡	1.70‡	20.00‡	22.00‡	1.34	1.04	.1260	2.15
St. Louis............	3.45	2.95	2.80	22.00	24.00	1.42	1.09	.1341	2.25
San Francisco............	3.55	2.475	2.325	23.00	28.00	1.68	1.26	.1584	2.60
Seattle............	3.50	2.50	....	30.00	33.00	1.68	1.26	.1584	2.60

‡Base Mill Price. Note: Shapes, bars and piling subject to quantity discounts. §Mill Price plus freight to Minneapolis. †f.o.b. delivered.

PAINTING AND ROOFING SUPPLIES—F.O.B.

	RED LEAD Per 100 lb. in 500-lb. lots Dry	WHITE LEAD Per 100 lb. in 500-lb. lots♯ in oil	READY-MIXED PAINT Per gal., drums Graphite*	Aluminum†	Ferric Oxide‡	ROOFING SUPPLIES Carload lots, f.o.b. factory Rolls, slate surfaced, 85-90 lb., per sq.	Asphalt felt, per 100 lb.	Tar felt, per 100 lb.	Asphalt coating, per gal.	Tar pitch, 350-lb. bbl., per ton
Atlanta..........	$7.75	$10.50	$1.60	$3.10	.....	$1.81	$1.97	$2.90	$ .36	$25.40
Baltimore........	7.00	10.00	1.40	2.25	$1.90	2.35	2.55	2.55	.48	25.00
Birmingham......	7.25	10.50	2.35	2.35	1.85	2.20	1.79	....	.36	23.00
Boston..........	7.00	10.00	1.75	2.65	.04½x	1.90	2.90	2.90	.40	20.00
Chicago.........	7.00	10.00	1.85	2.45	1.30	1.60	1.59[a]	1.59[a]	.24	20.00
Cincinnati.......	7.00	10.00	1.45	2.50	1.40	2.40	2.39[a]	2.39[a]	.36	21.00
Cleveland........	7.00	10.00	1.65	2.30	1.30	1.60	1.79	1.79[a]	.24	22.00
Dallas..........	7.25	11.00	1.80	7.24	.....	2.40[g]	4.17	4.17	.15	35.00
Denver	7.50	10.75	2.55	.....	.....	2.75	3.46	3.46	.60	30.00
Detroit..........	7.00	10.00	1.45	2.20	1.30	2.55	2.80	2.55	.35	30.00
Kansas City......	7.00	10.12½	1.25	2.25	1.00	2.05	3.10–3.20	3.10–3.20	.23	26.50
Los Angeles......	7.25	10.25	1.60	2.25	2.30	2.00	1.50	.....	.45	.....
Minneapolis......	7.00	10.12½	.....	.....	.....	1.60	1.79[a]	1.79[a]	.29	25.30
Montreal.........	....	8.20	1.70	3.45	1.65	2.00	2.62	2.02	1.40§	1.52§
New York........	7.00	10.00	1.60	2.00	1.40	1.60	1.79[a]	1.79[a]	.232	22.00
Philadelphia.....	7.00	10.00	2.50	2.95	1.50	1.68	1.86[a]	1.48[a]	.37	22.00
Pittsburgh........	7.00	10.00	1.05	1.95	.80	1.75	1.65[a]	1.65	.38	25.00
St. Louis.........	10.00	10.00	1.85	2.45	1.30	1.87[g]	3.22	3.22	.28	20.00
San Francisco....	7.25	10.25	1.80	2.75	1.10–2.00	1.89	3.10	3.10	.38	26.00
Seattle..........	7.25	10.25	1.80	2.85	2.20	3.30	2.66	2.60	.60	30.00

*U. S. War Dept. Spec. 3-49A. †ASTM Spec. D266-31. ‡80% maximum ferric oxide. §Per 100 lb. [a]Per roll, 65 lb. xPer lb. [g]500-lb. drums.
Note: Red lead in oil 50c higher than white lead in oil. ♯Basis of quoting changed this month from list to 500-lb. lots.

MISCELLANEOUS ITEMS

	WINDOW GLASS Discounts from latest jobbers ist, Sept. 15, 1928 Single or Double Thickness A quality	B quality	EXPLOSIVES Per lb. dynamite delivered 50-lb. cases Gelatin 40%	60%
Atlanta............	85%	85%	$0.155	$0.17
Baltimore............	88–10%	90–10%	.16	.175
Birmingham............	88%	90%	.105	.120
Boston............	88–10–5%	90–10–5%	.185	.195
Chicago............	90%	92%	....	....
Cincinnati............	89–10%	91–10%	.27	.29
Cleveland............	89-10%	91-10%	.19	.205
Dallas............	86%	88%	.17	.185
Denver............	84%	86%	.155	.17
Detroit............	87–10%	89–10%	.237	.255
Kansas City............	87–10%	88–10%	.16	.175
Los Angeles............	90%*	90–40%	.1725†	.1925†
Minneapolis............	85%	87%	.175	.19
Montreal............	......	......	.1875	.2125
New Orleans............	88%	90%	.19	.22
New York............	88%	90%	.225	.24
Philadelphia............	88%	90%	.1550	.17
Pittsburgh............	88%	88%	.11	.1250
St. Louis............	90%	92%	.135	.15
San Francisco............	82%	87%	.1575	.1775
Seattle............	90–10%	90–20%	.1425	1575

*Disc. from list Aug. 1, 1929. †F.o.b. Arsenal. ‡Double thickness A & B

CHEMICALS

Water, sewage treatment, road work, f.o.b., carlots, New York:	
Bleaching powder, in drums, f.o.b. works, per 100 lb............	$1.90@$2.00
Calcium chloride, 77-80%, flaked, in 400-lb. drums or 100-lb. moisture proof bags, f.o.b. works, freight equalised with points of competition, per ton..................	22.00@35.00
Chlorine cylinders, per lb. delivered..................	.055@.06
Silicate of soda, 52 deg., in drums, f.o.b. works, per 100 lb..........	1.35
Soda ash, 58%, in paper bags, per 100 lb..................	1.23
Sulphate of aluminum, commercial, in 100 lb. bags per ton........	27.00
Sulphate of copper, in bbl., per 100 lb..................	3.85

PILES

Prices per linear foot, pine, with bark on f.o.b., New York; delivered from barge, 1½ to 2c. per ft. additional:

Dimensions	Points	Length	Short Leaf Barge	Rail	Long Leaf Barge	Rail
12in. at butt..........	6in.	30 to 50 ft.	$0.12	$0.165	$0.13	$0.16
12in.—2ft. from butt.	6in.	50 to 59 ft.	.16	.21	.15	.20
12in.—2ft. from butt.	6in.	60 to 69 ft.	.17	.225	.16	.21½
14in.—2ft. from butt.	6in.	50 to 69 ft.	.195	.235	.20½	.24½
14in.—2ft. from butt.	6in.	70 to 79 ft.	.2125	.245	.24½	.30½
14in.—2ft. from butt.	5in.	80 to 85 ft.	.275	.385	.....	......
14in.—2ft. from butt.	5in.	85 to 89 ft	.315	.452	.....	......

RAILWAY TIES

Prices f.o.b., per tie, for carload lots:

		6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
Boston.......	Oak, untreated..................	$1.20	$1.75
	Pine, untreated..................	1.25	1.75
	Pine, creosoted..................	1.70	2.40
New York....	Long-leaf sap pine, untreated.....	.80	1.00
	Mixed oak, untreated............	....	1.00
	White oak, untreated............	.75	1.50
Birmingham .	White oak, creosoted............	no market	
	Southern pine, untreated *6x8x8′6″	.45*	.60
	Southern pine, creosoted..........	1.00*	1.20
Chicago......	White oak, untreated............	1.15	1.40
	Oak, empty cell, creosoted.......	1.50	1.88
	Oak, zinc treated	1.40	1.70
	Southern pine, creosoted.........	1.35	1.78
Los Angeles..	Fir, untreated..................	.50	.72
	Fir, creosoted..................	1.67	2.40
Philadelphia..	Red oak, untreated..............	1.00	....
	Red oak, creosoted..............	....	2.10
St. Louis	White oak, untreated............	1.03	1.35
	Red oak, untreated..............	.95	1.30
	Red oak, creosoted..............	1.40	1.90
	Sap Pine or cypress, untreated....	.80	1.20
San Francisco	Douglas fir, green, untreated.....	.45	.63
	Douglas fir, empty cell, creosoted.	1.14	1.56
Montreal....	Birch or maple, untreated........	1.00	1.10
	Birch or maple, creosoted........	1.25	1.55

CURRENT PRICES OF CONSTRUCTION MATERIALS

WATER, SEWER AND DRAIN PIPE

	C. I. PIPE	VITRIFIED SEWER PIPE				CLAY DRAIN TILE		CONCRETE SEWER PIPE		WROUGHT STEEL PIPE			
	Per net ton, f.o.b. 6 in. to 24 in.*	Per foot, delivered, standard (‡ f.o.b.)				Per 1,000 ft., carload lots, f.o.b.		Per ft., delivered; ASTM C 14-24		Full standard weight. #			
		8 in., s.s.	12 in., s.s.	24 in., d.s.	36 in., d.s.	6 in.	8 in.	12 in.	24 in.	1 to 3 in., Butt Weld Black	1 to 3 in., Butt Weld Galv.	3½ to 6 in., Lap Weld Black	3½ to 6 in., Lap Weld Galv.
Atlanta	$43.00	$0.225	$0.405	$1.4625	$3.25	$80.00	$128.00	$0.50	$1.625	44%	37%	42%	34%
Baltimore	46.50	.25	.50	2.10	5.75	108.00	168.50	.75	2.00	....	....	....	....
Birmingham	39.00	.25	.45	1.625	4.66	85.00	200.00	.45	1.60	48.939%	37.918%	50.162%	39.143%
Boston	46.50	.196	.378	1.72	5.06	51.10	85.85	.378	2.15	....	....	....	....
Chicago	47.50	.285	.54	1.98	5.60	85.00	120.00	.675	2.25	56%	45%	55%	46
Cincinnati	46.00	.203	.3915	1.665	5.125	69.00	108.00	.40	1.40	53.04%	42.02%	54.265%	43.245%
Cleveland	47.50	.196	.378	1.62	5.0225	47.25	72.00	.536	2.102	58.4%	48.4%	60.6%	49.6%
Dallas	51.00	.25	.45	1.80	.....	160.00	250.00	.41	1.41	64%	55%	64%	56%
Denver	59.00	.23‡	.415‡	1.73‡	.....	.....	......	.....	.....	56%	45%	43%[a]	57%[a]
Detroit	47.50	.245	.4725	2.025	5.74	82.00	136.00	.35	1.20	48.6%	38.2%	47.3%	37.6%
Kansas City	49.00	.32	.57	2.27	4.90	120.00	240.00	.40	1.50	56%	47%	57%	48%
Los Angeles	47.50	.2825‡	.508‡	2.03‡	5.535‡	115.50	192.50	1.00	2.00	53.57%	43%	53%	42.51%
Minneapolis	49.50	.255	.459	1.836	4.67	.....	......	.50	1.34	....	....	....	....
Montreal	55.00	.80	1.50	6.00	.....	45.00	90.00	.45	.....	....	....	....	....
New Orleans	45.00	.32	.51	1.65	.....	67.00	......	.45	2.00	....	....	....	....
New York	46.00	.26	.51	2.25	6.75	.....	......	.55	2.00	51.88%*	40.86%*	53.10%*	42.08%*
Philadelphia	43.00	.336	.648	2.835	8.68	175.00	210.00	.54	1.80	52.37%*	41.35%*	53.39%*	42.57%*
Pittsburgh	49.00	.175‡	.3375‡	1.44‡	4.81‡	69.00	108.00	.75c	1.75	64%	55%	65%	56%
St. Louis	46.00	.55	.459	1.836	3.96	85.00	170.00	.80	2.00	51.266%	40.245%	52.49%	41.47%
San Francisco	47.00	.265	.477	1.908	5.22	103.50	172.50	.45	2.20	52.4%	63.4%	51.1%	64.6%
Seattle	48.50	.35†	.63†	2.52†	6.30†	96.00	200.00†	.50†	1.80	60%	50%	65%	50%

*b. & s. class B and heavier, C/L lots, 200 tons and over. Burlington, N. J. (base) $43.00. Gas pipe and class A, $3 per ton additional, 4-in., $3 per ton additional. 30 in. and larger usually $2 per ton less. ‡Price at factory. †Less 30% in C/L Lots.

#Discounts from standard list for delivery from warehouse, except Pittsburgh prices are f.o.b. mill. Base price $200 per net ton. List prices per ft.: ½ in., 8½c; ¾ in. 11½c.; 1 in., 17c.; 2 in., 37c.; 2½ in., 58½c.; 3 in., 76½c.; 4 in., $1.09; 6 in., $1.92. [a] 2½ to 3 in. *Resale price to consumer, car load lots shipped from mill.

c Concrete Culvert pipe reinforced.

LUMBER AND TIMBER—PER M FT. B.M., CARLOAD LOTS F.O.B.

		SHORT LEAF YELLOW PINE AND DOUGLAS FIR									LONG LEAF Y. P.	
		All S. L. Y. P. is No. 2 common or better and for No. 1 N. C. Box. All Fir planks No. 2 common; Fir timber is No. 1 common. Lengths up to 20 ft.									Merchantable grade up to 20 ft.	
		1x6,[S]	1x8,[S]	2x4,[S]	2x6,[S]	2x8,[S]	2x10,[S]	3x12,[R]	6x12,[R]	12x12,[R]	2x12,[R]	12x12,[R]
Atlanta	Southern Pine	$16.00	$16.00	$18.00	$18.50	$20.00	$19.50	$28.00	.....	.....	$38.50	$40.00
Baltimore	Southern Pine	20.50	24.00	29.50	28.50	29.00	30.50	37.50	.....	.....	54.00	55.00
	Douglas Fir	29.50	29.00	31.00	29.00	30.00	30.50	32.00	$33.00	$34.00	.....	.....
Birmingham	Long Leaf	17.00	17.25	17.25	15.25	16.25	16.25	38.00	.....	.....	33.00	35.80
	Southern Pine	17.00	17.25	16.00	14.00	15.00	15.00	25.00	25.00	24.00	.....	.....
Boston	Southern Pine	28.00	28.00	35.00†	37.00†	51.00‡	60.00‡	73.00‡	.....	.....	73.00	73.00
	Douglas Fir	28.00	28.00	35.00	35.00	35.00	37.00	40.00	43.00	43.00	.....	.....
Chicago	Southern Pine	27.00	28.00	33.50	30.00	31.00	32.50	45.00	.....	.....	53.00	57.00
	Douglas Fir	28.50	29.50	31.75	30.50	30.50	28.50	40.75	41.75	41.75	.....	.....
Cincinnati	Southern Pine	24.00	25.00	26.00	25.00	25.50	26.50	40.00	.....	.....	31.50	.....
	Douglas Fir	.....	.....	.....	.....	.....	.....	43.50	46.25	46.25	.....	.....
Cleveland	Southern Pine	26.00	28.00	32.00	28.00	30.00	32.00	45.00	43.00	.....	48.00	58.00§
Dallas	Southern Pine	d31.50	32.40	35.55	32.50	35.50	35.50	55.00	.....	.....	51.90	64.35
Denver	Douglas Fir	35.00	35.00*=	41.00*	44.00*	44.00*	46.00*	52.00*	56.00*	61.50	.....	.....
Detroit	Southern Pine	24.00	24.00	25.00	24.50	24.50	25.50	35.00	.....	.....	29.00	41.50
	Douglas Fir	.....	.....	.....	.....	.....	.....	41.50	41.50	41.50	.....	.....
Kansas City	Southern Pine	24.50	25.50	24.50	24.50	24.50	26.50	37.00	.....	.....	54.50	60.50
	Douglas Fir	24.50	27.75	26.75	26.75	26.75	28.50	37.00	37.00	37.00	.....	.....
Los Angeles	Douglas Fir	24.00[y]	25.50[y]	26.00[y]	26.00[y]	26.00[y]	26.00[y]	38.00[y]	30.00[y]	34.00[y]	.....	.....
Minneapolis[c]	Western Pine	45.00*	51.50*	50.00*	41.00*	41.00*	42.00*	59.50*[b]	.....	.....	58.00*[b]	.....
	Douglas Fir	39.00*	42.00*	43.50*	41.00*	41.00*	42.00*	59.50*	59.50*	59.50*	.....	.....
Montreal	Spruce	30.00	31.00	27.00	29.00	32.50	35.00	38.00	.....	.....	.....	.....
	Douglas Fir	47.50	53.00	42.50	44.00	44.00	45.75	51.00	51.00	51.00	43.00	.....
New Orleans	Southern Pine	24.05	26.00	30.00	26.00	27.00	27.00	39.00	.....	.....	45.00	55.00
	Douglas Fir	28.95	31.50	33.90	29.35	32.90	33.95	37.95	.....	.....	.....	.....
New York	Southern Pine	34.00*	35.00*	34.00*	35.00*	36.00*	37.00*	45.00*	.....	.....	70.00*	70.00*
	Douglas Fir	.....	.....	38.00*	37.00*	38.00*	39.00*	38.00*	42.00*	42.00*	.....	.....
Philadelphia	Southern Pine	30.00	31.00	32.00	32.00	33.00	34.00	36.00	.....	.....	36.00	42.00
	Douglas Fir	45.00	45.00	45.00	45.00	45.00	45.00	45.00	42.00	42.00	.....	.....
Pittsburgh	Southern Pine	30.50	31.90	37.65	33.75	36.52	37.50	47.75	.....	.....	57.50	57.50
	Douglas Fir	38.52	39.70	39.70	38.55	39.10	39.38	53.25	53.25	53.25	.....	.....
St. Louis	Southern Pine	29.00*x	30.00*x	30.00*x	29.00*x	29.50*x	30.00*x	50.00*x	.....	.....	65.00*x	65.00*x
	Douglas Fir	.....	.....	.....	.....	.....	.....	55.00*x	55.00*x	55.00*x	71.00	69.00
San Francisco	Douglas Fir	20.00[t]	20.00[t]	21.50[t]	21.50[t]	22.00[t]	22.50[t]	24.50	25.00[t]	25.00[t]	.....	.....
Seattle	Douglas Fir	14.00	15.00	15.00	14.00	14.00	14.00	20.00	19.00	19.00	.....	.....

*Delivered. †Spruce. ‡Long-leafed Y.P. §Norway Pine. [b] Northern Pine. =Native. [t] At ship's tackle. [y] Yard prices. [d] 10% Disc. taken off. x5M ft. or less [S] S4S. [R] Rgh. [c] Contractors in Minneapolis and St. Paul get 20% disc. from list.

CURRENT BUILDING AND CONSTRUCTION WAGE RATES PER HOUR

	Bricklayers	Carpenters	Structural Iron Workers	Hoisting Engineers	Plasterers	Common Labor	
						Building	Heavy Const.
Atlanta	$0.70/1.125	$0.40/.90	$0.60/1.25	$0.60/1.25	$0.60/1.00	$0.30/.40	$0.30/.40
Baltimore	1.25	1.10	1.37½	1.25	1.25	.45	.45
Birmingham	1.00	.60/1.00	1.00	1.125	1.00	.30/.40†	.30/.40†
Boston	1.20	.70/1.17½	1.20	.90/1.37½	1.37½	.50/.70	.50/.70
Cincinnati	.80/1.375	.65/1.20	1.25	1.00/1.25	.90/1.375	.45	.45
Chicago	1.50	1.31¼	1.35	1.31¼	1.50	.82½	.82½
Cleveland	1.25	1.12½	1.25	1.125	1.37	.72	.72
Dallas	.50/1.00	.50/1.00	.50/1.00	.50/1.00	.50/1.00	.25/.40	.25/.40
Denver	.60/1.12½	.60/.87½	.60/.87½	.60/.87½	......	.50	.50
Detroit	1.25	1.00	1.25	.75/.95	1.25	.55/.60	.55/.75
Kansas City	1.32½	1.12½	1.125	1.12½	1.32½	.70	.45/.50
Los Angeles	1.10	1.10	1.25	1.25	1.25	.50	.60
Minneapolis	1.00	.75	1.20	.75	.90	.45	.45/.50
New Orleans	1.00	.75	1.00	1.00	1.25	.30/.40	.30/.40
New York	1.50	1.40	1.65	1.50/1.65	1.50	.82½	.50/.80
Philadelphia	.35/1.50	.65/1.10	.70/1.375	.90/1.00	1.10/1.37	.35/50	.40/.50
Pittsburgh	.50/1.00	.50/1.00	.50/1.00	.50/1.00	.50/1.00	.35/.50	.35/.50
St. Louis	1.50	1.25	1.47	1.37½	1.50	.78½	.35/.78
San Francisco	1.50*	1.10	1.37½	1.12½	1.25*	.62½	.60
Seattle	1.00	1.00	1.25	1.25	1.25	.60	.60
Montreal	1.00	1.00	1.25	1.25	1.25	.60	.60

Skilled Avg: (Bricklayers, Carpenters, Ironworkers) $1.084 Common Avg. $0.5285 *6-hr. Day. † PWA.